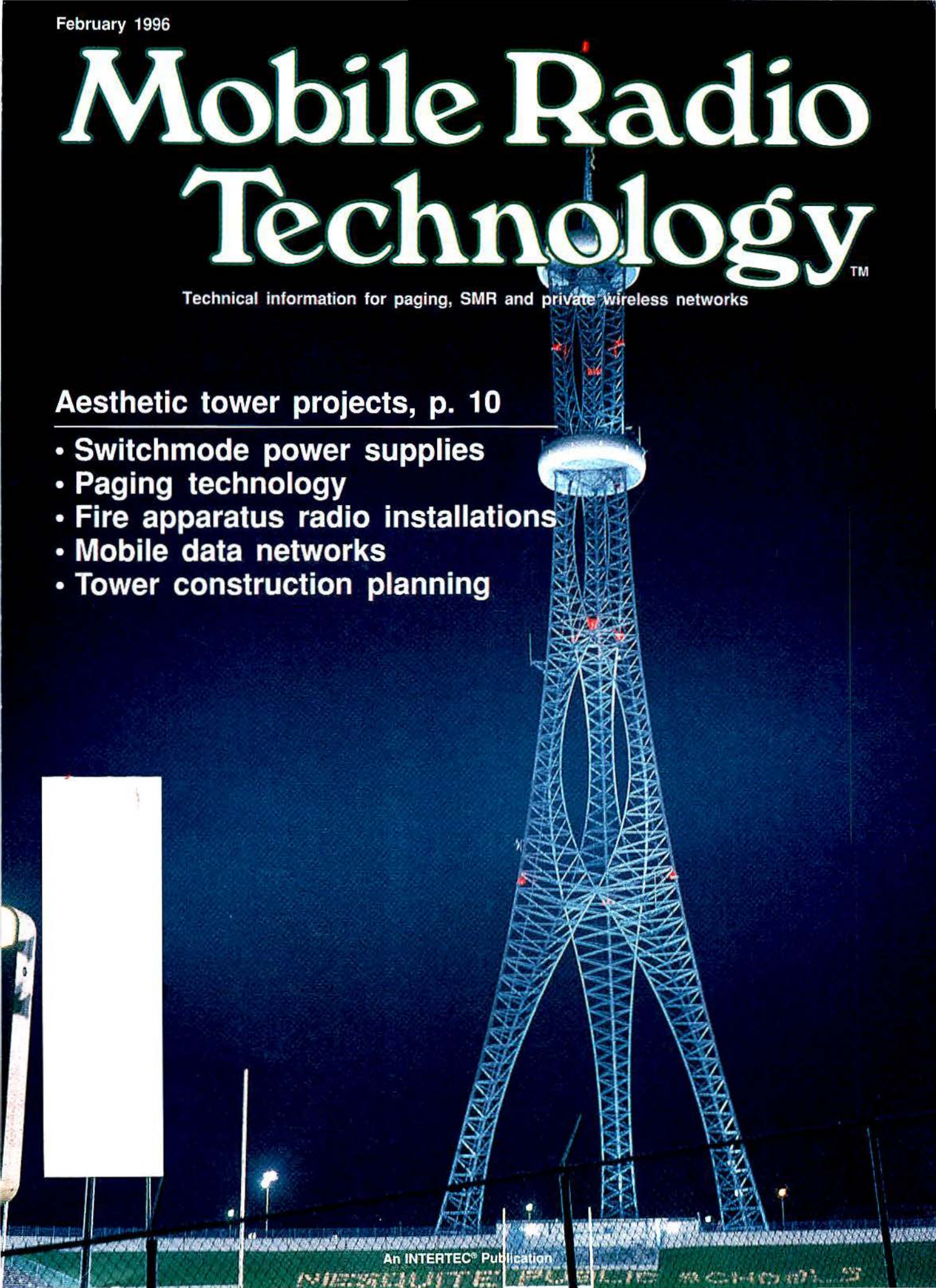
February 1996

Mobile Radio Technology™

Technical information for paging, SMR and private wireless networks



Aesthetic tower projects, p. 10

- Switchmode power supplies
- Paging technology
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- Mobile data networks
- Tower construction planning

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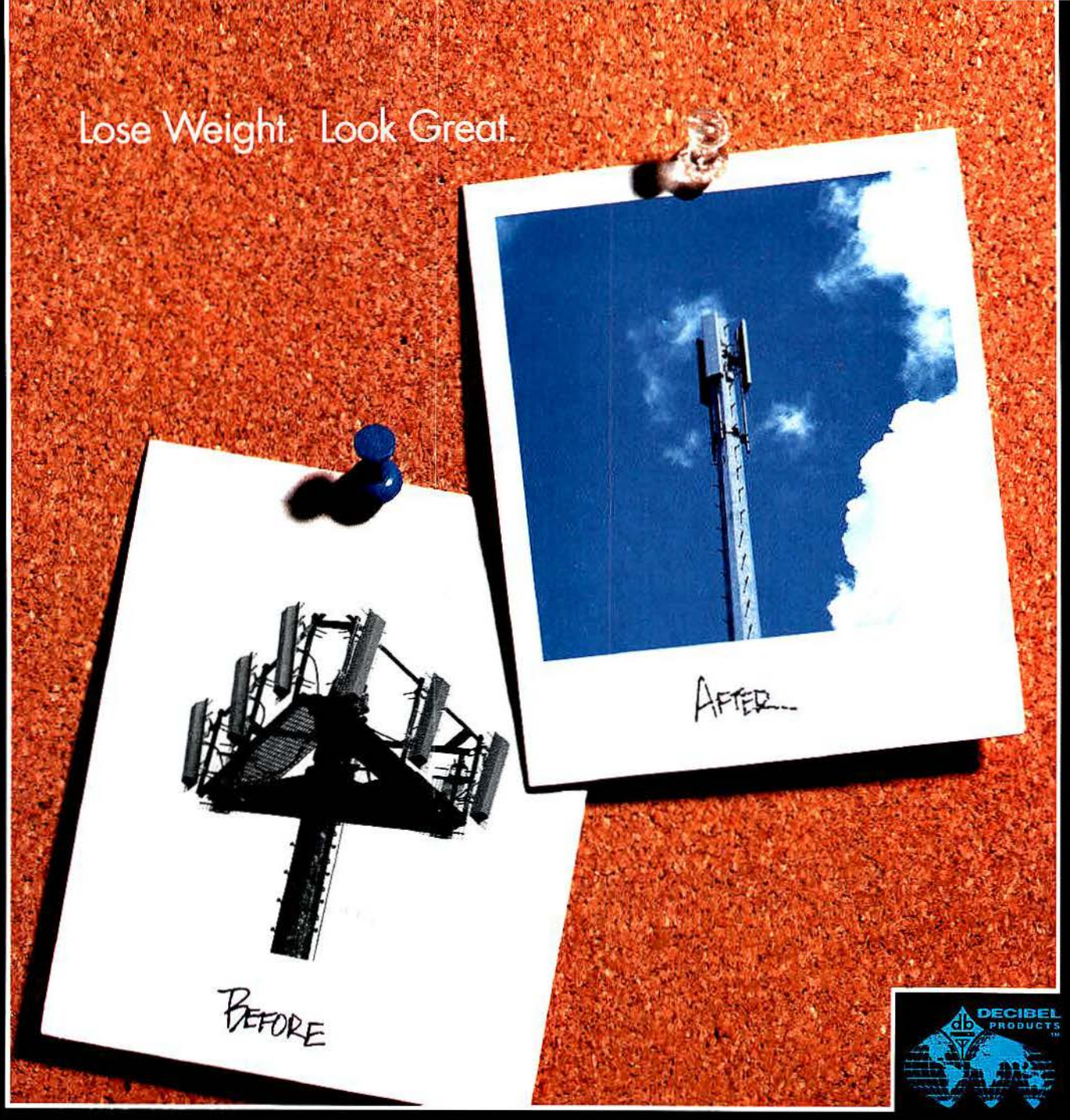

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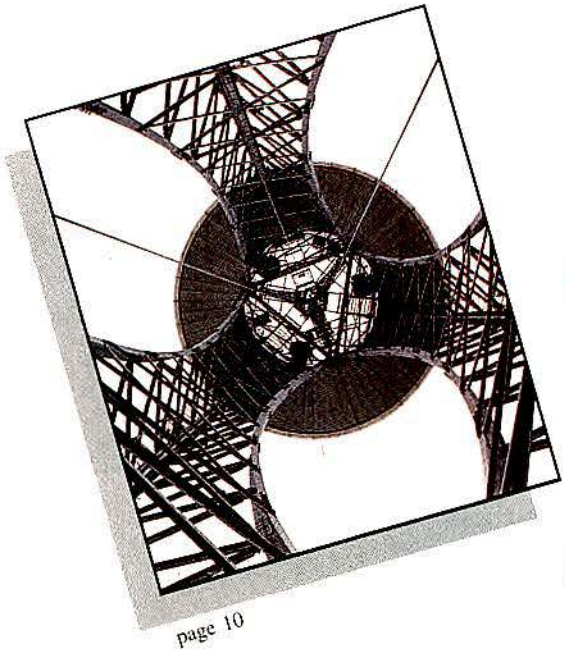
Contents

Mobile Radio Technology™
Technical information for paging, SMR and private wireless networks
Volume 14, Issue 2



page 10

page 46

features

10 Towers benefit local efforts at revitalization and growth
Henry J McGinnis, P.E.
Attractive towers overcome objections to allow optimum placement to support greater coverage and to generate maximum rental income.

18 Designing for power: Using switchmode supplies
David Ludvigson
Use the LT-1070 switchmode ICs to make highly efficient power supplies for dc-powered RF equipment that save space.

26 Paging technology: Systems and services
Lynne Stewart
Part 1—Here is a look at the technology behind the fast-growing paging industry.

30 Radio installation tips for fire fighting equipment
Donald E. Koehler
Involve customers early when installing communication systems in fire fighting equipment.

36 An introduction to mobile data networks
Dan Monopoli
Use your applications provider as a sounding board and obtain a commitment regarding functions that it provides now and that it plans to provide as you define your network requirements.

46 The ABCs of communications towers
Betty J. Pilar
Determine initial and future uses for your new tower. Select a tower manufacturer and a tower installer with good reputations. Inspect and maintain your tower regularly.

On the cover: The Landmark tower in Mesquite, TX, has an aesthetic design and nighttime wash lighting (augmented for this photograph) that have made the tower popular. See Henry J McGinnis's article on page 18.

departments

4 Editorial
Scanning.

6 Calendar

8 Technically speaking
Harold Kinley, C.E.T.
RF switching with PIN diodes.

61 Regulating technology
Robert H. Schwaninger Jr.
The spectrum and loan scandal.

63 News
PCS Development signs agreement with Westlink Paging.

64 New products
Brown and Schwaninger is the "Readers' Choice."

69 Literature

70 People

71 Classified ads

88 Ad index/hot line
Find advertisers quickly.

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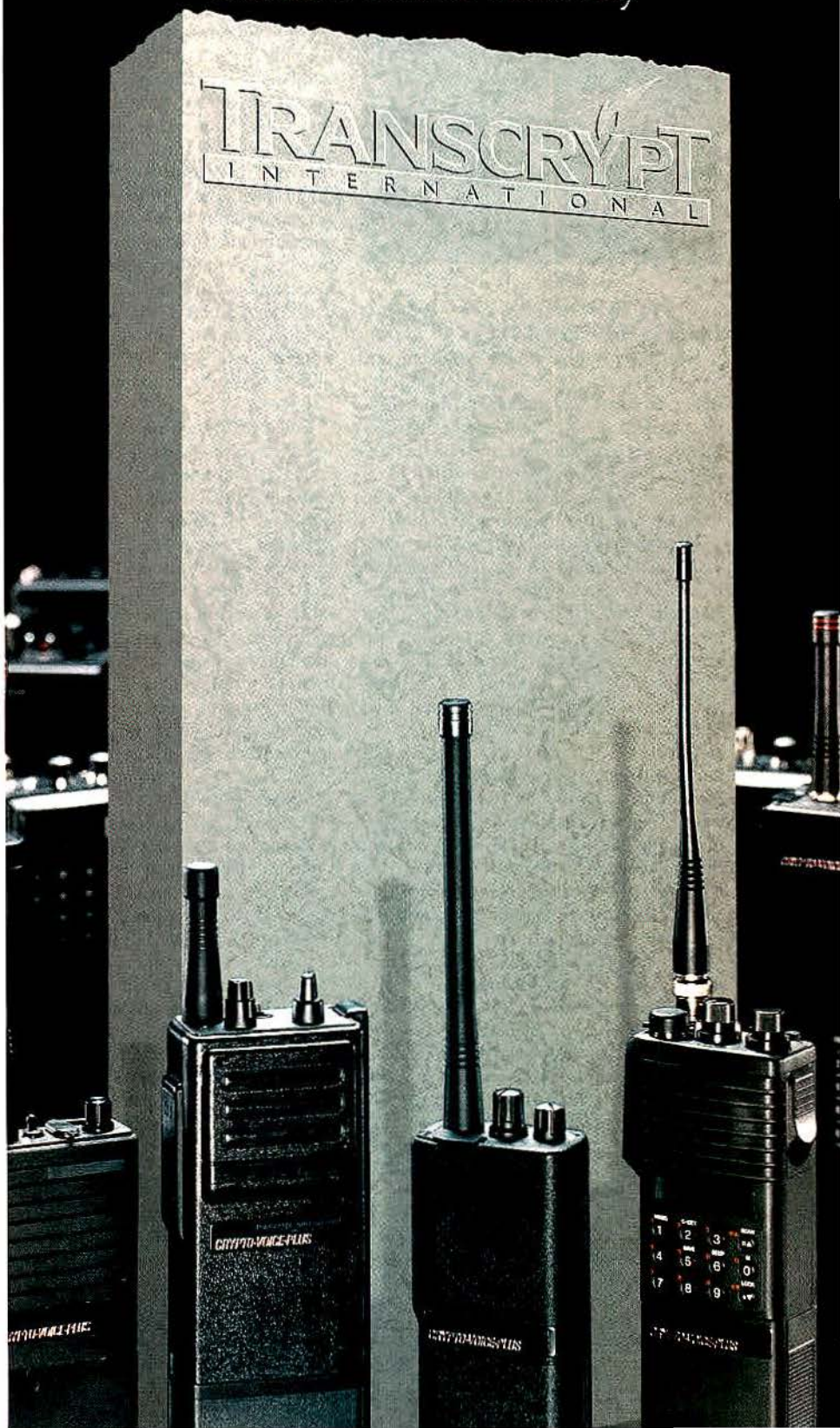

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Scanning . . .

Oh boy! Maps *and* TV!

Ever been riding in a car with someone who reads maps while driving? That habit unnerves some passengers, yet some drivers seem to have to look at the map for themselves to understand the route to their destination. Pull over and stop to look at the map? No way! Let the passenger read the map and give directions? *Un-uh.*

How about the driver who watches television while behind the wheel? That hasn't been much of a problem—yet. In several states, in fact, it has been illegal to place any "TV-type receiving equipment" in automobiles, including Florida, Kansas, Maryland, Nevada, Pennsylvania, Tennessee, Texas, Utah and Wyoming. Until now. Thanks to the advance of technology.

Wireless communications networks now can relay *vehicle navigation* information for display on small monitors (about 7 inches wide) to assist the driver in finding the way. These devices allow drivers to send emergency distress signals, receive directions, check their current location on a map and track mileage information on trips.

With the Consumer Electronics Manufacturers Association leading the way, the nine states that restricted TV-type receivers in automobiles have amended their laws to permit the use of vehicle navigation devices.

We like maps. We like TV, too. With a vehicle navigation device in our car, we get to watch maps on TV. What could be better? We may have to give up taking passengers, though. They're just too *nervous.* (You know who you are.)

Phone cops

Cooperating with federal authorities and taking self-protection against cellular fraud to a new level, NewVector technicians in Santa Fe, NM, helped U.S. Secret Service agents to arrest three suspects on Jan. 9. The Secret Service has primary jurisdiction over cellular fraud crimes.

Hundreds of thousands of dollars worth of long-distance calls were initiated during a six-week period on cellular phones illegally programmed with identification numbers that would have caused unknowing, legitimate subscribers to be billed for the calls. About 95% of the fraudulent charges were identified before they reached NewVector customers' bills. Programming cellular phones to steal service, a process known as "cloning," involves entering stolen phone numbers and electronic serial numbers into other handsets. Once a phone has been cloned, unlimited calls can be placed that are billed to the original account. Cloned phones often are used in "call sell" operations in which thieves sell calls to individual users for a flat fee.

Fraud analysts with US West Cellular, which does business as NewVector, detected an unusually high number of international calls on several cellular phone numbers in Phoenix. The technicians tracked the phones as they moved from Phoenix to Tucson, AZ, to Albuquerque, NM, and then to Santa Fe, NM. Using radio direction-finding equipment, the technicians pinpointed the source of the fraudulent calls to a motel. Private investigators hired by the cellular company kept the motel under surveillance until federal agents could obtain warrants to search the motel rooms and make the arrests.

Support from the Secret Service and the 9th Judicial District Attorney's Office in New Mexico was considered by US West Cellular as critical to the successful apprehension of the suspects. "If they had not acted when they did, it's possible the suspects would have left town in a matter of hours," said company spokesperson Lisa Bowerstock.

As unfortunate as it is that cellular technology allows phone numbers and electronic serial numbers to be stolen, at least network traffic analysis methods have been developed to detect fraud, and the venerable techniques of radio direction-finding help system operators to find the thieves.

What's a fair price?

Cellular fraud costs the industry an estimated $3 billion per year. Some consumer groups suggest that "price-gouging" by system operators costs the public twice that much per year. They claim that because only two operators serve each market, providers can keep prices higher than they should, and consumerists consider it to be gouging.

Cellular companies say they charge what is necessary to recover capital construction costs. Critics claim these costs were recovered during the first 18 months of operation in most metropolitan areas. Whether the 18 months estimate is true or not, are capital costs still being recovered 10 years after most systems were built?

The next defense, first heard about 1989, was the need to bank money to convert analog systems to digital. Few systems have converted, and maybe only a few more conversions are likely. Less-expensive technologies are available to increase capacity, and estimates of capacity requirements have been reduced in the face of potential competition from personal communications service (PCS) system operators. Competition may succeed in bringing down cellular service prices where regulation and protest have failed.

Blizzard of '96

The east coast froze in early January's Blizzard of '96. Here's a quick check of what's still frozen at the FCC in Washington, DC:

- 220MHz SMR applications.
- 800MHz SMR applications.
- 900MHz SMR applications.
- 800MHz General Category applications.
- 800MHz interservice sharing applications.

Last fall, the FCC processed 40,000 SMR applications filed before the freeze and found that 6,500 could be granted. Petitions filed in connection with the process are preventing licenses from being issued. If and when the licenses are issued, an estimated 12,000 new channels may be built, representing healthy business for equipment manufacturers.

Some of the freezes (moratoriums on accepting new applications) will never be lifted, with the current application process to be replaced by an auction process. In the near future, new business may be focused on business and industrial communications systems below 800MHz, opportunities in spectrum refarming and new public safety system construction.

—Don Bishop

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Calendar

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11-13—Western States Regional Conference of the International Association of Public-Safety Communications Officials, Riverpark Convention Center, Spokane, WA. Contact: Pamela Ratcliffe, 206-774-3583.

17–20—Energy Telecommunications and Electrical Association, Dallas Convention Center, Dallas. Contact: 214-235-0655.

25-27—Wireless, sponsored by the Cellular Telecommunications Industry Association, Dallas. Contact: 202-785-0081.

April

24-26—International Wireless Communications Expo, Las Vegas Convention Center, Las Vegas. Contact: 800-828-0420.

29-May 1—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society,Westin Peachtree Hotel, Atlanta. Contact: Jim Worsham, 404-804-3543.

May

14-17—PCIA Spring Government Conference, sponsored by the Personal Communications Industry Association, Washington Hilton, Washington, DC. Contact: Nancy Palleschi, 202-467-4770.

29–31—Canadian Wireless, sponsored by the Canadian Wireless Telecommunications Association, Metro Toronto Convention Center, Toronto. Contact: 613-233-4888.

June

16-20—UTC National Conference & Exhibition, sponsored by UTC, The Telecommunications Association, Marriott Hotel and Bartle Hall Convention and Civic Center, Kansas City, MO. Contact: 202-872-0030.

24-27—Supercomm, sponsored by USTA and TIA, Dallas Convention Center, Dallas. Contact: 202-326-7300.

July

11-13—Communications Expo/Show of the Americas, Miami, FL. Contact: 305-229-9992.

14–17—Forestry-Conservation Communications Association annual conference, Howard Johnson Plaza Hotel, Madison, WI. Contact: Tom Tuttle, 608-246-7998.

August

11-15—International Association of Public-Safety Communications Officials (APCO) National Conference, San Antonio, TX. Contact: 800-949-2726.

September

19-21—Personal Communications Showcase, sponsored by the Personal Communications Industry Association, Moscone Convention Center, San Francisco. Contact: 800-326-8638.

October

30-Nov. 1—WirelessWorld Conference and Exposition, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Orange County Convention/Civic Center, Orlando, FL. Contact: Susan Link, 913-967-1969.

November

15—Radio Club of America, Communications Symposium, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

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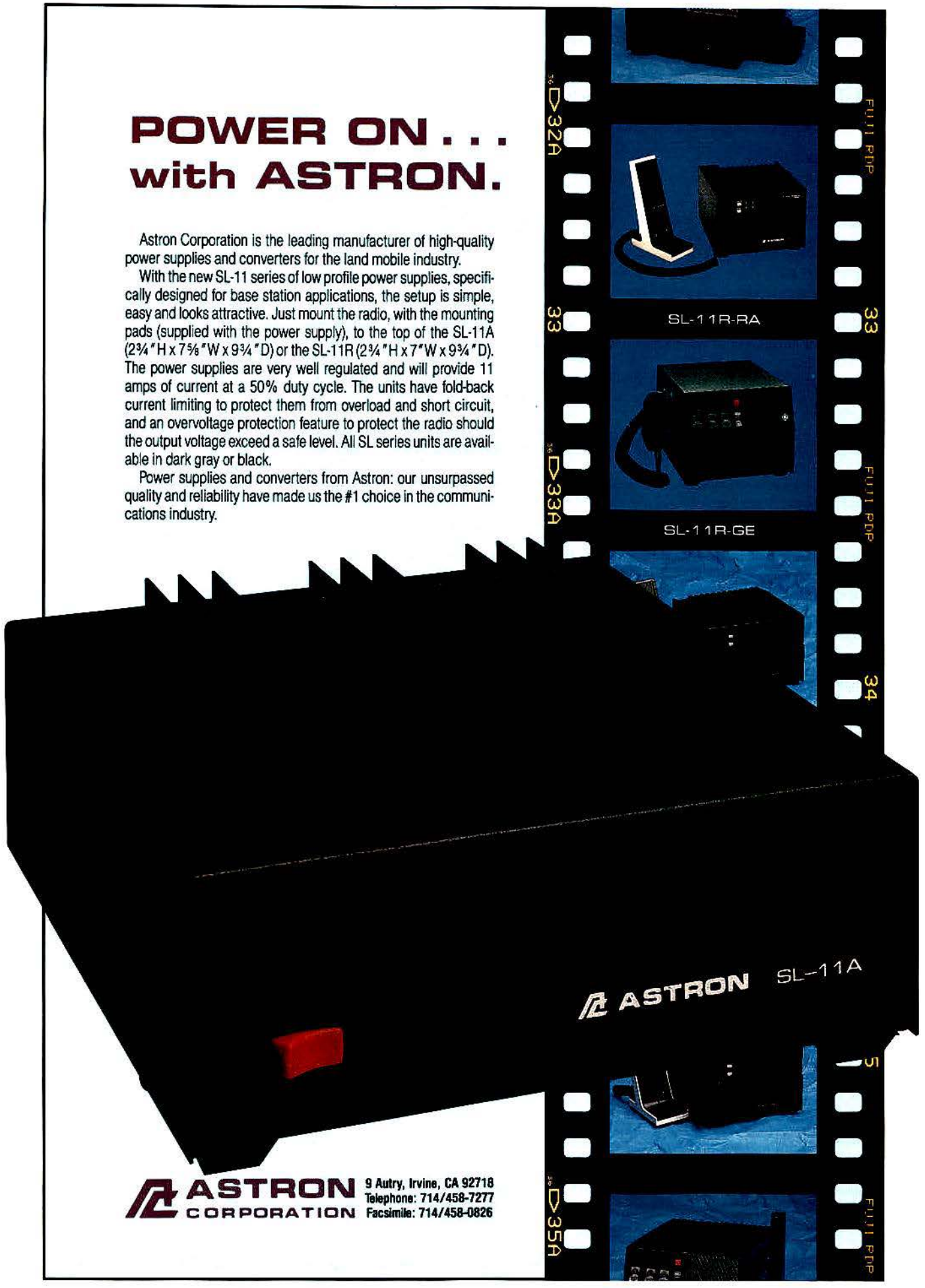

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RF switching with PIN diodes

By Harold Kinley, C.E.T.

If you have worked in the radio communications field for long, you remember when antenna switching was done by relay. In fact, many sets still use relay switching. Relays are mechanical devices (moving parts), and with any mechanical device comes wear and tear. Remember cleaning the relay contacts as part of preventive maintenance? Not only did the contacts become dirty and pitted, the contacts on some relays had a habit of becoming out of alignment. People using radio equipment with dirty or misadjusted relay contacts often would complain of an "insensitive receiver." Usually, troubleshooting was easy: Simply measure the resistance of the contacts with an ohmmeter or bypass the relay temporarily to observe the result.

Besides the problems with dirt, wear and misalignment, the mechanical relay has the disadvantage of higher cost and larger space requirement. The space requirement is not as important in base stations as it is in mobile and portable equipment.

PIN diode

The word PIN is an acronym for *positive intrinsic negative*, which refers to the diode's construction. Heavily doped "N" and "P" sections are separated by an "intrinsic" section of silicon that acts as an insulator. (See Figure 1 below left.) When forward bias is applied to the diode, the intrinsic region is injected with carriers from the "N" and "P" sections to allow the intrinsic region to become conductive. A normal PN junction diode, shown in Figure 1A, has a fairly high junction capacitance and, therefore, would leak RF signals through the junction capacitance. The thickness of the intrinsic region of the PIN diode substantially reduces the capacitance. This makes the PIN diode quite suitable for RF-switching applications.

The *forward-biased* PIN diode behaves as a pure resistance at RF frequencies. The RF *resistance* of the PIN diode can be varied from less than 1Ω to more than 10,000Ω by controlling the bias current through the diode. Although it is true that most diodes behave in a similar manner, the PIN diode is specifically designed to cover a wide range of resistance with good linearity and low bias current. PIN diodes can be connected as shunt (parallel) or series devices and often are used in series-parallel combinations.

Typical circuits

Basically, a PIN diode can be used to perform almost any type of RF switching. Some of the more common uses are described here in simplified form.

□ *Antenna TX/RX switch.* Figure 2 below shows how PIN diodes can be used for antenna TX/RX switching. When +12V is applied to the top of R2, bias current flows through R2, L1, D1, the quarterwave line section, D2 and R1. This flow causes both the PIN diodes, D1 and D2, to be forward-biased. Because D1 is forward-biased, the transmitter signal will pass on to the antenna.

With D2 forward-biased, that end of the quarterwave transmission line will be at a low impedance point. Because a quarterwave section of line causes an impedance transformation, the transmitter side of the line will present a high impedance to the transmitter output signal. This provides isolation between the shunt diode, D2, and the transmitter output to prevent the shunt diode from loading down the transmitter output. The isolation can be an actual quarterwave section of transmission line, a lumped constant circuit or a strip line on the circuit board.

When +12V is removed from the top of R2, the bias current is interrupted, and the PIN diodes are then effectively open. This

(continued on page 59)

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301.

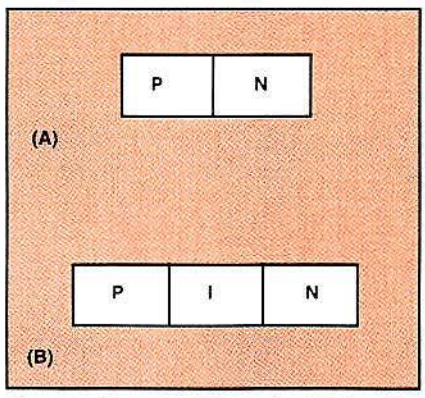


Figure 1. (A) represents a typical PN junction diode. (B) indicates a PIN diode. Notice the intrinsic layer separating the "P" and "N" sections.

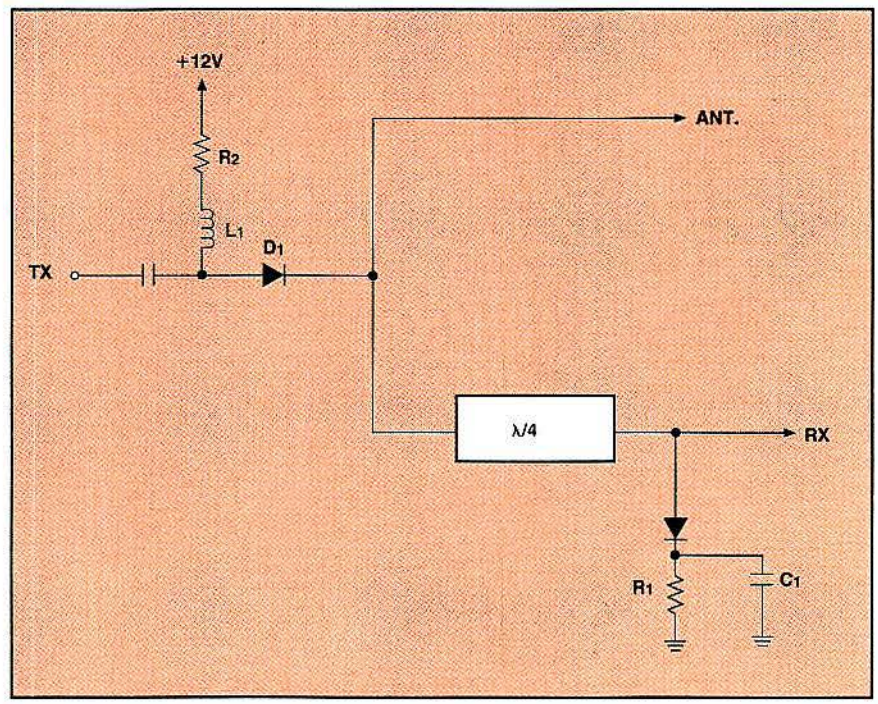
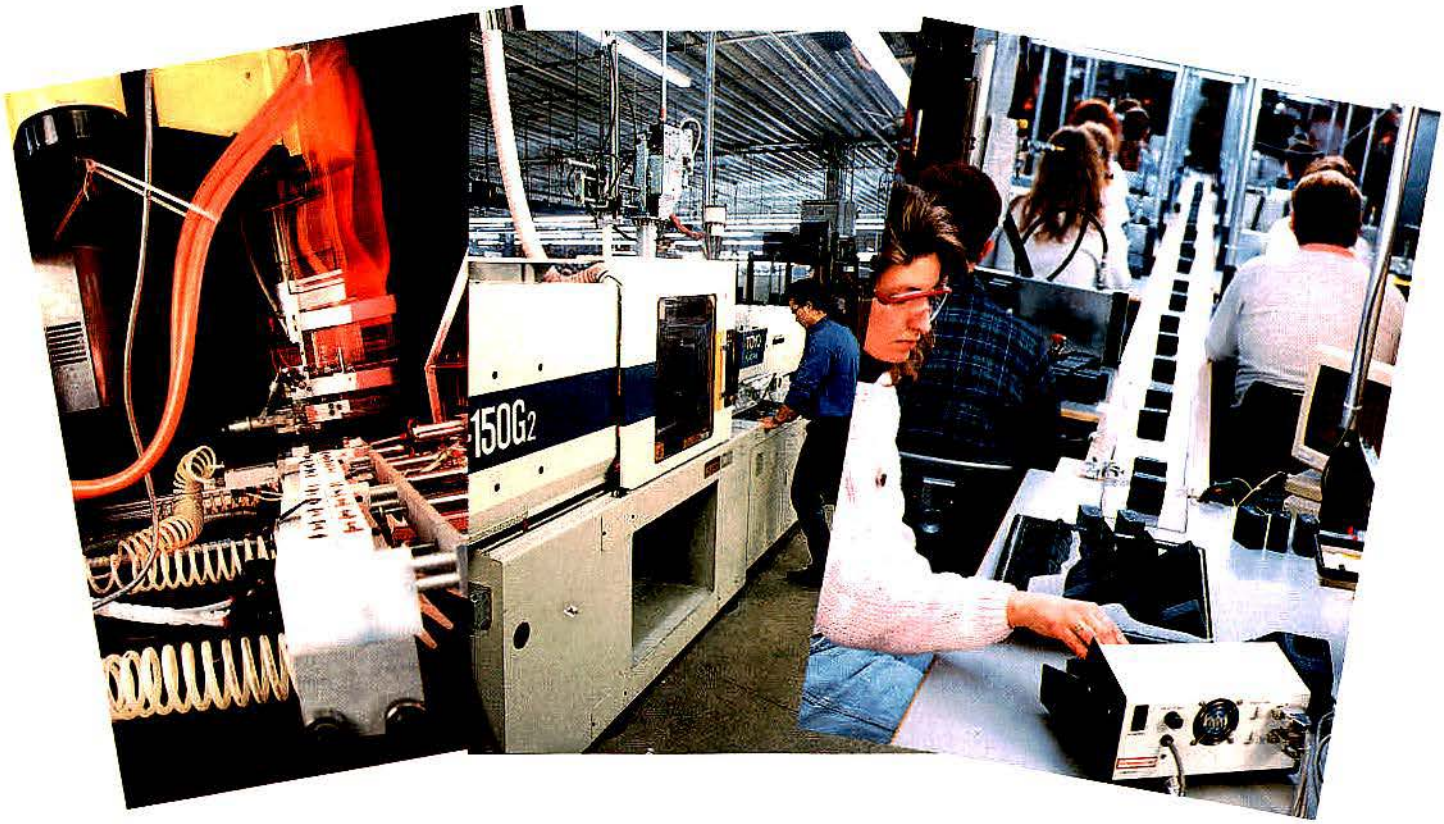


Figure 2. A simplified schematic of an antenna switching circuit using PIN diodes. See text for description of operation.

A Powerhouse.



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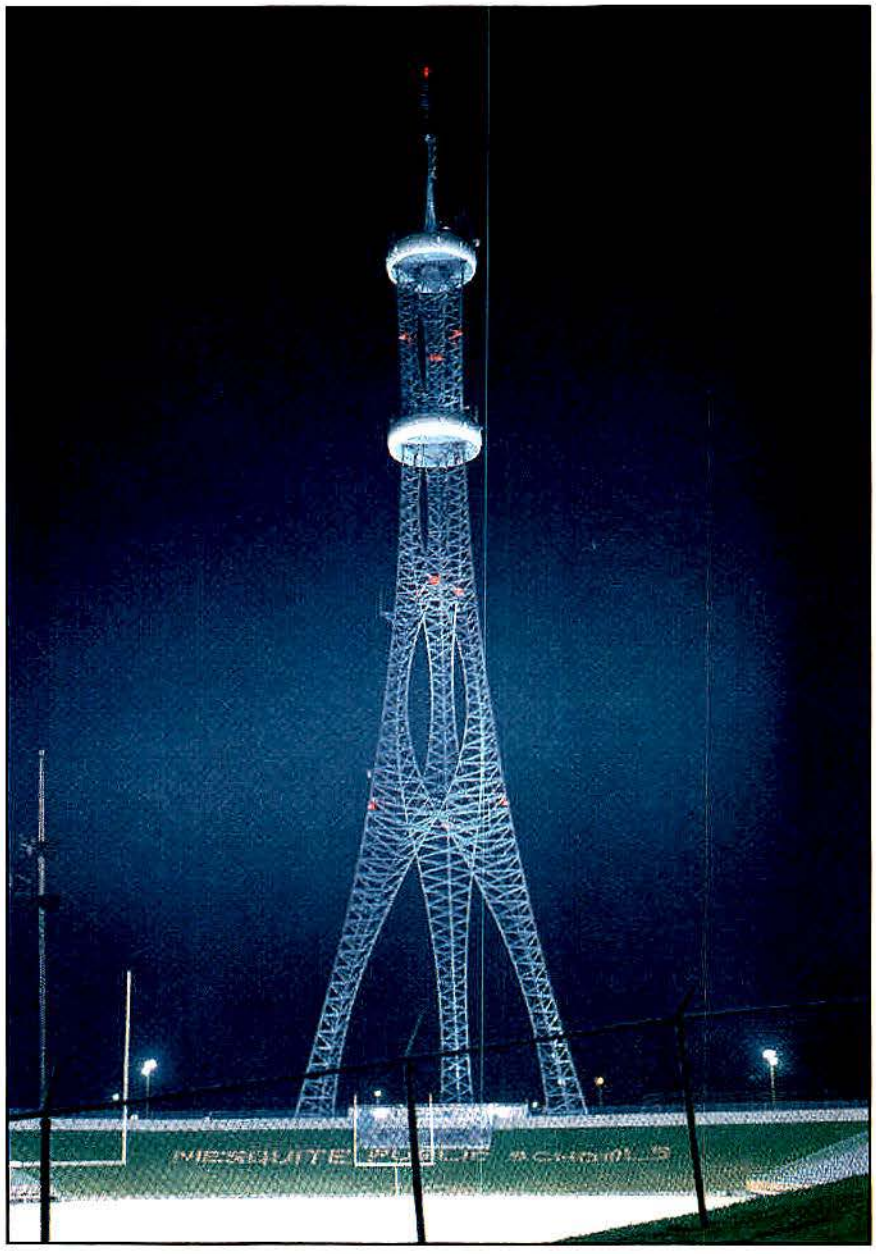
Towers benefit local efforts at revitalization and growth

Aesthetics draw citizen support for tower projects. How's that again? Attractive towers overcome objections to allow optimum placement to support greater coverage and to generate maximum rental income.



Henry J McGinnis, P.E.

Many cities are struggling to reverse the devastating effects of urban flight, which leave them with decaying neighborhoods, abandoned buildings and shrinking tax bases. Many times, city-owned properties, such as athletic fields and parks, become neglected, run-down centers for criminal activity that hinder any revitalization effort.

Jackson, MS, took a bold step to combine revitalization with a dramatic improvement to its city government telecommunications. The city placed a 503-foot tower at an abandoned, city-owned athletic field that became the primary site in its new trunked radio system. The tower's aesthetic design helps to convert a previously unproductive site in a manner that brings beauty and distinction to the neighborhood. Already, an adjoining land parcel is being developed for new housing. More growth will undoubtedly follow.

Although urban flight represents a growing problem, progressive cities such as Jackson, MS, and Mesquite, TX, have taken steps to prevent it. Preventing urban flight can be made more complicated when

Photo 1. The Landmark Tower type II in Mesquite, TX, fits requirements developed by the Mesquite Independent School District's and the city government's study group. The tower's aesthetic design and its nighttime wash lighting, augmented for this photograph, have made the tower popular.

McGinnis is president of Landmark Tower, Fort Worth, TX. The company manufactures the Landmark type I and type II towers, the Skypod tower-mounted equipment rooms and the Vexcel (vertical excellence) lift elevator described in the article. The MISD complex is managed by ATMCO, a part of the Landmark family of companies.

citizens object to towers. Towers, through the communications that they carry, are absolutely necessary to maintain city services, to protect personal safety and property, to satisfy consumer communications demands and to attract and retain businesses.

Central location

Maximum coverage and penetration for radio-based telecommunications such as public safety radio communications, private wireless business networks and cellular telephone require a transmission site to be carefully located. Towers need to be central to the city to provide a wide service radius.

Decisions about tower placement cause turmoil. A city government can expect a battle between citizens and service providers over every tower construction permit. Some permits have been delayed as long as six years because of citizen opposition. Some permits eventually are denied. Usually, citizens suffer the most from delays and denials because necessary communications systems are not implemented on a timely basis.

What can be done to change the people's minds about towers in their neighborhoods?

The Mesquite Independent School District (MISD) needed a tower for its KEOM-FM radio station, a tower that could be shared by city government and private communications services.

Overcoming opposition

Mesquite citizens had expressed opposition to the prospect of towers popping up everywhere across the city. As a result, the MISD leadership enlisted the aid of the City of Mesquite so their combined radio communications requirements and those of private service providers could be met with one project.

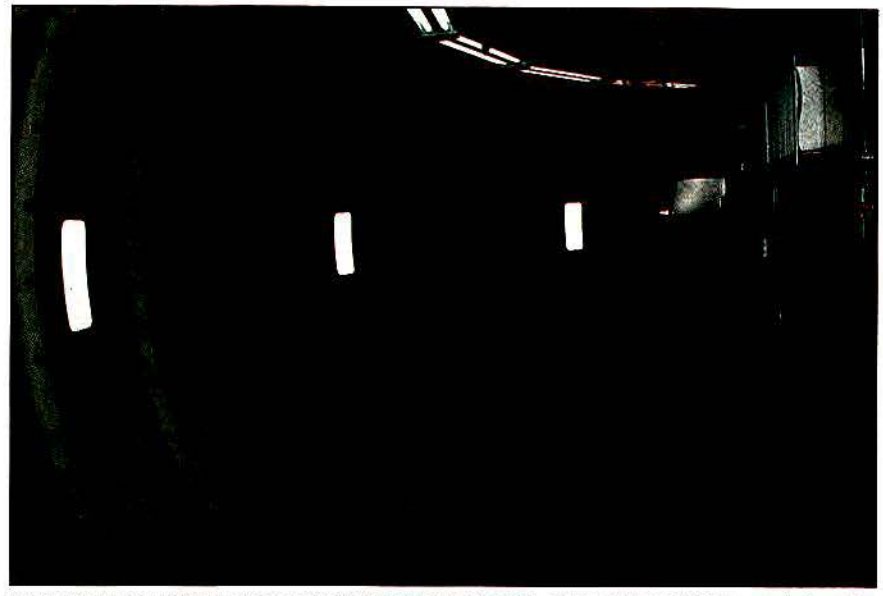


Photo 2. The need for security and efficiency led to the use of two Skypod tower-mounted equipment rooms, one at 310 feet, and the other at 400 feet. This view shows the interior of one of the rooms.

A study group determined that the combined requirements included the following:

- reliable 9-1-1 services.
- back-up power.
- minimum maintenance.
- privatization of the site technical management.
- security.
- expandability.
- strength and stability for microwave antennas.
- monitoring of the tower, equipment environment and fence.
- aesthetics.

The tower shown in Photo 1 on page 10 was chosen as the type that would best meet these requirements. The communications complex was planned so one large facility could serve the entire area instead of using multiple smaller towers throughout the city. The basis for the patent that covers the tower is the tower's ability to be upgraded and its ability to carry superior payload per pound of steel for a comparable structure.

Rental revenue

Tower rental space for wireless

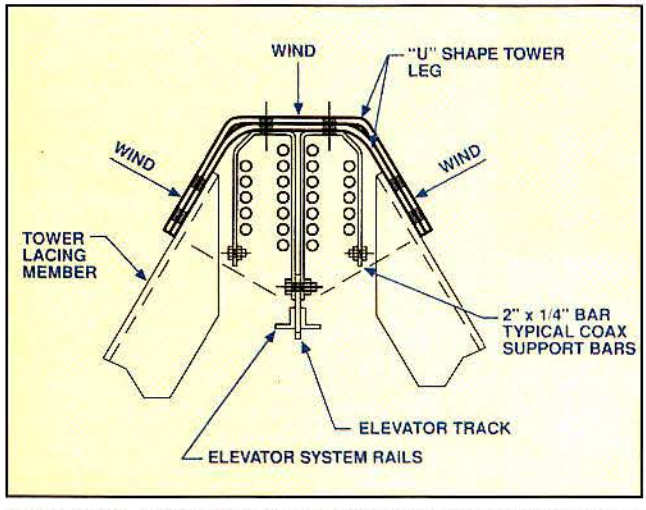


Figure 1. The structure's folded-plate "U"-shaped leg members allow coaxial transmission lines to be placed inside the leg members where they are protected from wind loading, ice loading and rifle fire.

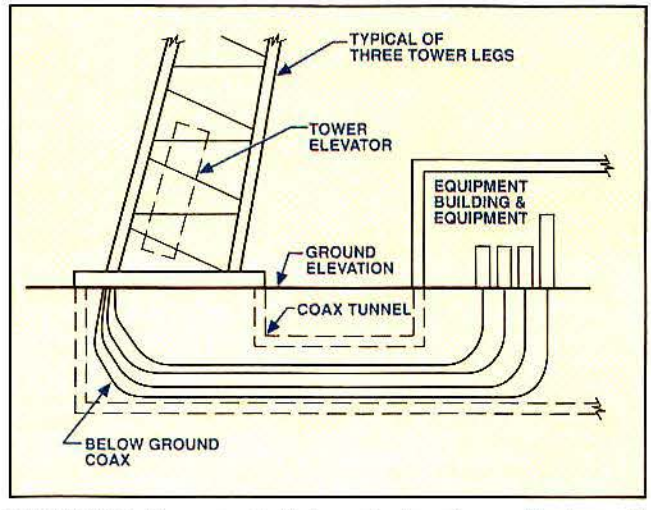


Figure 2. Where they are routed between the tower legs and the transmitter building, the coaxial cables are protected by tunnels.

communications service providers is bringing a return on the joint investment made by the City of Mesquite and the MISD. By constructing the central communications complex, the city and the MISD have turned one of its problems into a revenue source.

The tower's wash lighting at night enhances the beauty and character of the city and has made the tower popular. It's wide stance virtually eliminates twist and sway, making it ideal for microwave transmissions. The wide stance and triple-leg truss design makes the tower reliable with respect to wind loading and seismic safety factors.

The structure's folded-plate "U"-shaped leg members allow coaxial transmission lines to be placed inside the leg members where they are protected from wind loading, ice loading and rifle fire. (See Figure 1 on page 11.) Where they are routed between the tower legs and the transmitter building, the cables are protected by tunnels. (See Figure 2 on page 11.) Aside from security, the tunnels resolve three other important considerations:

(1) The coaxial cables have room to make large sweeping turns that avoid kinks in the line.

(2) The tunnels allow the elevators in each leg to be stationed at an elevation of only six inches above the concrete foundation for easier loading and unloading.

(3) Placing the coax below ground level prevents it from carrying a portion of the tower's high voltage gradient caused by lightning. For example, with a potential voltage gradient of 300,000V between the top of the 515-foot structure and the ground during lightning strikes, coax routed at ground level would be suspended in a voltage gradient of about 5,000V. Safeguarding workers and equipment from potential injury or damage from voltage on the coaxial cable would be an additional requirement that is avoided by using the tunnels.

After studying several lightning-deterrent systems, my company's engineers chose the system manufactured by Lightning Deterrent, Wilmington, IL. They thought the system would give the overall best protection, and after two years of operation, the system has proven to be satisfactory.

The need for security and efficiency led to the use of two tower-mounted equipment rooms. (See Photo 2 on page 11.) The lower equipment room is at 310 feet, and the other is at 400 feet.

Elevated equipment rooms

Although some RF equipment is in the building at ground level, there are many benefits to placing equipment at elevation. Less transmission line is required to reach the antennas, reducing the line cost and improving the effective radiated power (ERP). The tower-mounted room's galvanized steel top, bottom and inside wall provide good protection in that, electronically, they resemble a faraday cage. Each room is provided with the following:

- 15 tons of air conditioning.
- electric toilet.
- halo grounding system.
- 200-pair telephone punch down block.
- dual-protection fire alarm system.
- fire-suppression systems consisting of 7% Halon (CO_2 in the ground building).
- 12 windows to prevent claustrophobia.
- 400A, 440V primary power service and 100A emergency power
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- ½" drywall interior vertical surfaces.

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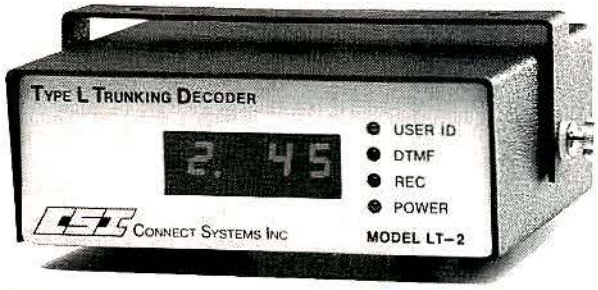

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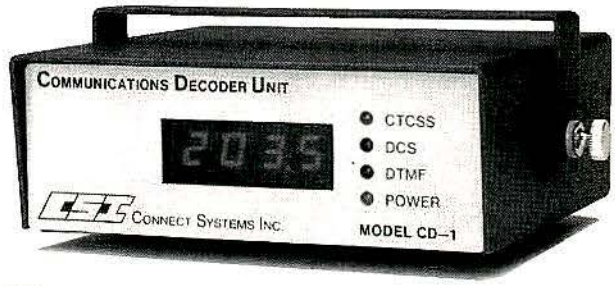

The **CD-1** Displays all CTCSS, DCS and DTMF codes on the channel you are monitoring. DTMF sequences (up to 128 digits) are stored and replayed slowly so that you can observe fast ANI codes. Only one connection required to any service monitor or scanner. Thousands in use worldwide.

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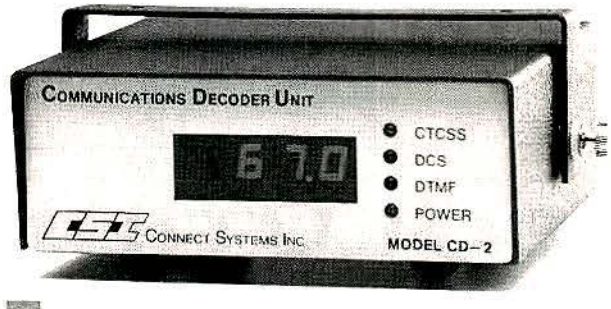

The all new **CD-2** is operationally identical to the **CD-1** with the addition of an **RS-232** serial port.

The optional **CD-2P** application program allows your IBM compatible PC to store and display the following as it occurs, on the channel you are monitoring...

- CTCSS Code
- DCS Code
- DTMF sequences
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- Airtime per DCS/CTCSS Code
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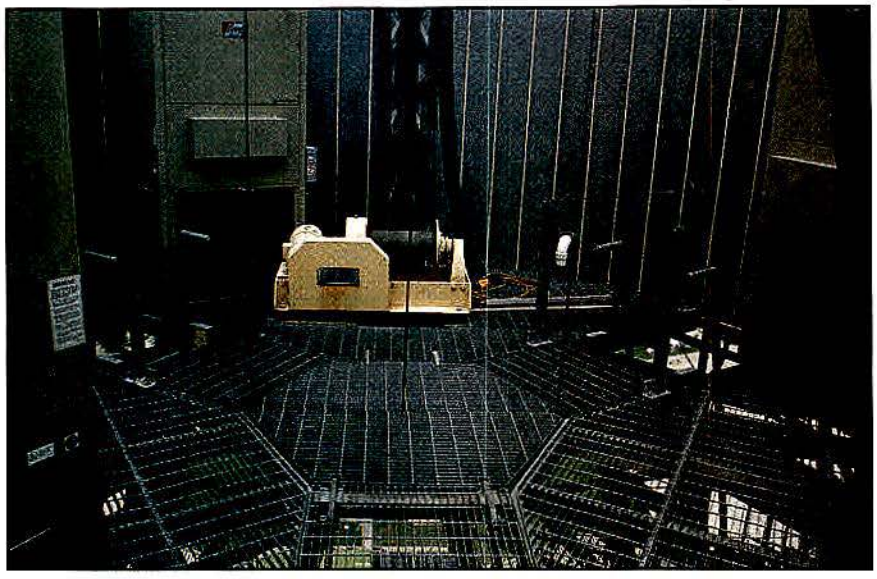

Photo 3. The landing platforms at each elevated room span the space between the room and the interior of the tower.

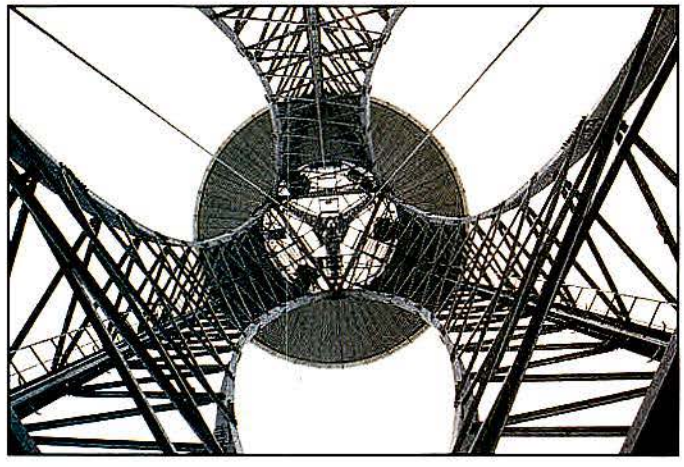

Photo 4. Both top and bottom landing platforms at each elevated room are equipped with counter-balanced hexagonal doors in the grating for easy opening. The heavy-duty freight elevator passes through these openings as equipment is hoisted to the various equipment room levels.

- insulation on floors, back walls and ceiling.
- individual circuit breakers for each radio duplex outlet.
- fluorescent lighting system.

The landing platforms at each elevated room span the space between the room and the interior of the tower. (See Photo 3 to the left.) Both top and bottom landing platforms are equipped with counter-balanced hexagonal doors in the grating for easy opening. The heavy-duty freight elevator passes through these openings as equipment is hoisted to the various equipment room levels. (See photo 4 below.)

Each equipment room has about 1,000 square feet of air-conditioned floor space that permits ample room for radios and microwave antennas. One customer has installed 11 8-foot-diameter microwave antennas in the lower room, and there is much more space still available. The fact that the wind-tunnel-tested aerodynamic drag coefficient will not be altered by the 11 antennas makes the selection of the tower-mounted equipment room for this structure even more credible. The 44-foot diameter rooms have nine feet of inside vertical clearance to the ceiling. These dimensions allow ample horizontal spacing for antennas mounted on the room's top railing and ample vertical space for RF equipment installation. The elevated rooms allow easy access to the associated antenna.

Elevator access

Access to the rooms normally is by cable-drawn lift units. Most cable-drawn elevators are subject to a certain amount of wind movement. Together with other

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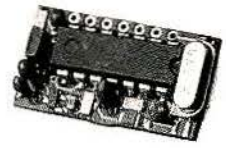

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- Available with flying leads

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- Microminiature quick disconnect connector with color coded leads for simplified installation and removal. Available with optional flying leads.

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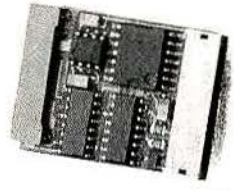

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undesirable factors associated with cable-drawn tower elevators, instability in windy conditions led to a two-year development program that included 30 years of life testing for a new type of tower elevator. The new lift includes the following attributes:

- no cables or gear racks.
- runs on curved surfaces as well as straight surfaces.
- operator-controlled from inside the cab.
- tambour doors for complete enclosure while in motion.
- speeds from 0 to 100 feet per minute are possible.
- choice of power supplies (electric Duct-O-Bar or gasoline engine).
- extensive list of accessories.

The lift is designed for retrofitting into any tower. Plans are being considered to replace at least one of the three existing elevators in the MISD communications complex with the new lift.

Construction financing

Financing is frequently an issue. A large tower, especially one that is part of a city, county or state communication complex, usually qualifies for traditional infrastructure financing, such as special-purpose bonds. Where infrastructure financing is unavailable or politically sensitive, the "personal property" character of a boltdown tower, loaded with equipment and accessories, substantially qualifies for traditional lease-financing. Some investment banking firms specialize in underwriting bond issues that directly or indirectly carry the backing of the municipality or other governmental unit. Similarly, some large asset-based lenders actively seek lease-financing deals for infrastructure projects that have the character of "equipment" and some form of backing by the governmental unit primary user. Finally, to the extent that capacity is built into the tower to accommodate outside revenue producing lease space, revenue-based financing options are made possible by using the future lease cash flow as security for the financing.

The MISD facility is a good example of a system that meets communications needs well into the next century. The initiation of this project exemplifies the progressive direction and management of Dr. John Horn, who has served as MISD superintendent for many years, and the skills of the district's systems engineer, Dennis Hevron.

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Designing for power: Using switchmode supplies

Use the LT-1070 and LT-1270 switchmode ICs to make highly efficient power supplies for dc-powered RF equipment that save space. Proper circuitry adequately filters and regulates the voltage output.

By David Ludvigson

With the steady demand for efficient output power, one area of amplifier design has been largely ignored. Amplifier designs may soon incorporate a "new" voltage-regulating technology, so let's take a look at *switchmode* power supplies.

Computer manufacturers have been using switchmode supplies for more than a decade. These supplies are not particularly "clean" as far as spurious outputs may go, but they possess several worthwhile qualities.

First, they are remarkably small. A 200W supply sits quietly in a corner of most 386 or 486 computers, occupying a footprint of perhaps 36 square inches.

Second, they do not require the utmost in input voltage regulation to perform well within their rated tolerances. If the supply is rated at 5V ±10% at 20A, this rating holds true with an allowable input variation of 90Vac–130Vac.

Third, these supplies use remarkably few components and a minimum of heatsinking. In short, they are *efficient.*

With these three major attributes in mind, let's take a closer look at "boost" or "step-up" switchmode power supplies.

'Boost' mode: the physics

Historically, many electrical engineering pioneers made use of electromechanical switching power supplies to increase output voltages. In essence, they consisted of equipment diagrammed in Figure 1 above. A modified version of Figure 1 incorporates a diode in place of the series switch. (See Figure 2 above.)

Operation of either version is identical. Dc rail voltage is applied to one end of an inductor. The other end of the inductor is alternately toggled between the source voltage and the load (represented in the figures as a capacitor). Output voltage from the capacitor consists of the rail voltage plus the voltage present across the coil as it discharges into the capacitor. Fully discharged, the coil merely represents a dc resistance in series with the load.

Ludvigson is a technician in Houston.

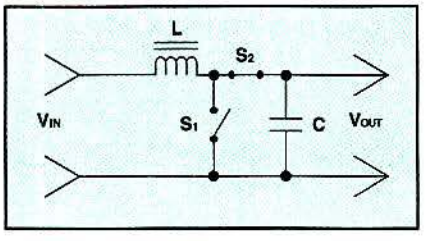

Figure 1. Electromechanical switching power supplies increase output voltages. S_1 is open when S_2 is closed and vice versa. The duty cycle of the combination of S_1 and S_2 determines the output voltage (V_{OUT}).

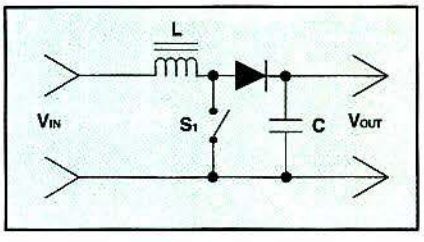

Figure 2. A modified version of the electromechanical switching power supply in Figure 1 incorporates a diode in place of the series switch. Again, the duty cycle of S_1 (ON/OFF) determines the output voltage (V_{OUT}).

Various ratios of S_1 "on" time to S_1 "off" time provide a simple voltage multiplier, as determined by the following formula:

$$V(\text{dc out}) = V(\text{dc in})/(1) - (\text{duty cycle})$$

Thus, a 50% duty cycle would result in:

$$V(\text{dc out}) = V(\text{dc in})/(1) - (0.5)$$

or

$$V(\text{dc out}) = V(\text{dc in})/0.5$$

for a voltage doubler.

Note that output voltage may be controlled entirely by changing the duty cycle of a "switcher."

The inductor

Achieving maximum performance from an inductor requires the solution to several formulas that find:

- the required value of inductance.
- the size of wire required to deliver a rated current.
- core size and permeability.
- the number of turns and insulation characteristics required to prevent failure of the inductor.

All these issues are fully discussed in Application Note 19, available from Linear Technology, 1630 McCarthy Blvd., Milpitas, CA 95035, tel. 408-432-1900.

The major design factor is "delta-I," the allowable maximum current change in the inductor as it moves from absorbing current to delivering current to the load. Typical "unregulated" supplies can allow this value to be as much as several amperes. (See Formula A on page 20.)

Formula B on page 20 provides a mathematical model representing the maximum available power using the inductance determined by Formula A. *R* (in the second term) symbolizes the effective resistance of the saturated transistor (emitter to collector) used in the LT-1070CK and LT-1270A. For the 1070, this value is typically 0.2Ω. For the 1270, it is typically 0.12Ω. The formula is used to determine the inductor and switching currents being removed from the maximum switching current that the transistor can maintain. This value is then multiplied by

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$$L = \frac{V_{IN}(V_{OUT} - V_{IN})}{(\Delta I)(F)(V_{OUT})}$$

where

F = 40kHz (40×10^3) for LT - 1070CK

or

F = 60kHz (60×10^3) for LT - 1270A

Formula A. Use this formula to determine the value of *L* for a given input and output voltage.

$$P_1 = V_{IN}\left[I_P - \frac{V_{IN}(V_{OUT} - V_{IN})}{2(L)(F)(V_{OUT})}\right]\left[1 - \frac{(I_P)(R)}{V_{IN}} + \frac{(I_P)(R)}{V_{OUT}}\right]$$

where

I_P = 5A for LT - 1070CK, 10A for LT - 1270A

F = 40kHz for LT - 1070CK, 60kHz for LT - 1270A

R = 0.2Ω for LT - 1070CK, 0.12Ω for LT - 1270A

Formula B. Use this formal to determine the power (in watts) available from the inductor in Formula A.

the input voltage to yield maximum power output from the inductor.

The diode

The "steering" diode has to perform the function of S_2 in Figure 1. Literally, it must be able to "toggle" as rapidly as the switching frequency—from full "on" to completely "off"—at a rate of 40kHz–60kHz. For this reason, Schottky diodes are recommended. Diodes from the 1N4000 series are ineffective at 60kHz, so *do not use them.* At higher output voltage levels, the "efficiency-factor" of the diode becomes less critical, allowing use of silicon fast turn-off diodes.

As with anything in electronics, where there is a voltage drop across a device and a current running through that device, there will be a power drop. Diodes are no exception. In this case, a typical Schottky diode will drop about 0.5V. This value is multiplied by the output current, resulting in:

P = V(voltage drop) × I(load).

Since this is a power *loss*, it must be included in the determination of overall efficiency, and it is subtracted from the available power at the inductor.

The 'filter' capacitor

The "filter" capacitor component smooths the output voltage and should have a low "equivalent series resistance" (ESR) value. ESR values are used to determine the overall "effectiveness" of a capacitor, similar to the use of "Q" as a means of defining the relative merit of a coil. To achieve the lowest ESR, capacitors *must* use the shortest connections possible to their respective junctions. As the ESR value decreases, the output ripple across the capacitor declines, resulting in an output devoid of the usual "droops" and "sags." In spite of the high frequency at which these "switchers" operate, output filtering is not just a simple matter of throwing a 0.1μF capacitor across the output and hoping for the best! Usually, values range from 150μF to several thousand microfarads for these components, and capacitors lacking low ESR values should be avoided, if possible. In some cases it might be practical to parallel several capacitors of the same value to achieve acceptable results.

This component is at the "tail-end" of

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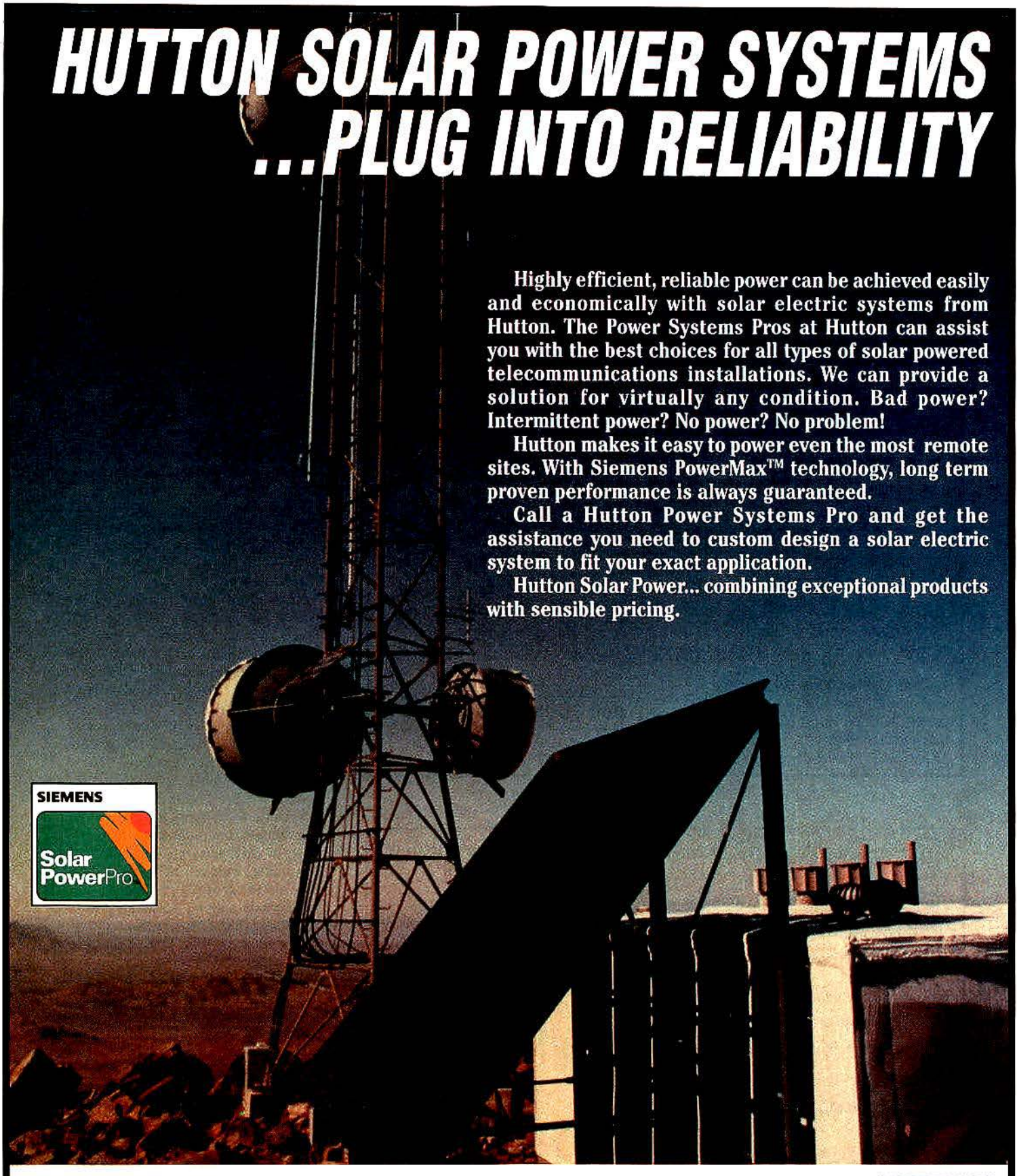

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HUTTON

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the switcher—but consider the work it must accomplish. First, it must maintain a steady dc voltage while absorbing energy from a coil that might be delivering some tens of watts at 40kHz–60kHz. It must also effectively bypass the switching frequency.

Switchmode power supplies often have output "ripple" that reaches several hundred millivolts peak-to-peak. To obtain cleaner outputs, an LC filter is added in series with the load. It often is possible to attain output ripple at less than 50mV peak-to-peak across the load using these small filters.

Short circuit protection

These switchers have nothing "built-in" to respond to an output short circuit. With the input dc rail and output dc rail sharing an inductor and diode in common, there is nothing to prevent "melt-down" should the load or a capacitor become a dead short. About the only device that could prevent drastic failure would be a fuse placed in series with the "hot" side of the load. Better yet, a fuse placed directly after the diode would save the switcher and inductor should the filter capacitor(s) or load fail.

The value for a *fast-acting* fuse can be calculated by the following equation:

$$I(fuse) = I(out) \times V(out)/V(in).$$

Provide a ×2 "fudge-factor," if necessary.

Observations on the math

After running through the math several times, you will find that "when I double the voltage, I halve the current." Welcome to energy conversion! Nothing is free.

What is very nice about these chips is the built-in voltage regulator. Output voltage is constantly being monitored by the "feedback" pin, and any change in output voltage is immediately compensated for by a change in operating duty cycle to maintain the required voltage.

Where to from here?

I was given an interesting problem. A warehouse had a new fleet of forklifts with a 12V battery power source. All of the data terminals and RF links used laser barcode readers and operated from 28Vdc–72Vdc with a rated current of 1.25A. Could I help?

Within a week, I delivered a working prototype. A week later, it was installed and running. My answer? The LT-1070CK in a simple variable-voltage configuration. (See Figure 3 on page 24.)

Because this supply is enclosed within a grounded aluminum box, there is little need for extensive shielding. Further, the data-linking transmitter is shielded and dc decoupled from the 28Vdc–72Vdc switchmode supply, so additional filtering would have been redundant. But I built a filter anyway, just to see how effective it would be.

A 10μH coil made of 12-gauge wire was placed in series with the dc output of the supply, along with a 100μF capacitor as the final output. My 150mV peak-to-peak ripple was reduced to less than 10mV peak-to-peak.

The voltage regulation is excellent. From no load to full-load, the voltage drops 0.02V! Not bad for a bit over an ampere of current! But even this regulation was improved.

Taking the "high" side of the 24K resistor to an unused terminal post allowed me to run a separate "sense" line directly to the load junction. Now the circuit was

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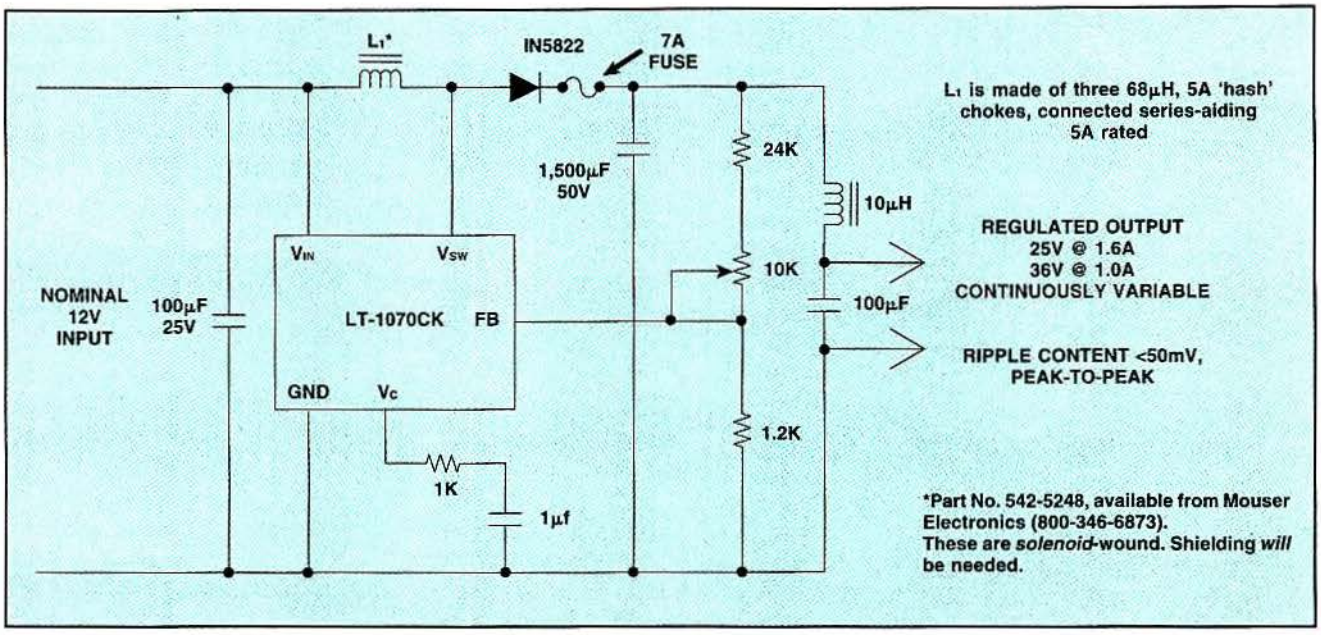

Figure 3. This diagram shows how the LT-1070CK was used to power a bar code reader and RF link from a 12V battery.

detecting the output voltage directly at the load and compensating for any I^2R losses in the interconnecting power lines. The no-load to full-load output voltage remained absolutely stable.

Being somewhat of a skeptic, I decided (hesitantly) to touch the top of the LT-1070CK while it delivered output into a pair of parallel 24V bulbs, each drawing about 800mA at 28V. The case was barely warm. I let it run for 8 hours. It was still barely warm. I must've grinned for nearly 8 hours!

What about RF?

With proper grounding, dc decoupling and shielding, it seems logical that such highly efficient supplies soon will find their place right next to RF stages. In a test circuit, the input voltage could drop to 10Vdc without affecting the output voltage. Voltage regulation from even my "homebrew" supply was superior, and designing it was a matter of following the AN19 notes from Linear Technology. Several other configurations of either the LT-1070CK or LT-1270A probably will find applications in medium-power voltage regulators. With their high efficiency, the need for massive heatsinks is replaced with more space for the rest of the technology.

Read all about it!

Application Note AN19 is in *1990 Linear Applications Handbook Volume I* available from Linear Technology outlets (Mil-Rep Associates, 6111 F.M. 1960 West, Suite 213, Houston, TX 77069, tel. 713-444-2557).

SwitcherCAD, an IBM-compatible program available on 3.5-inch or 5.25-inch diskettes, along with the *SwitcherCAD User's Manual*, is available for $20 from Linear Technology, 1630 McCarthy Blvd., Milpitas, CA 95035, tel. 408-432-1900.

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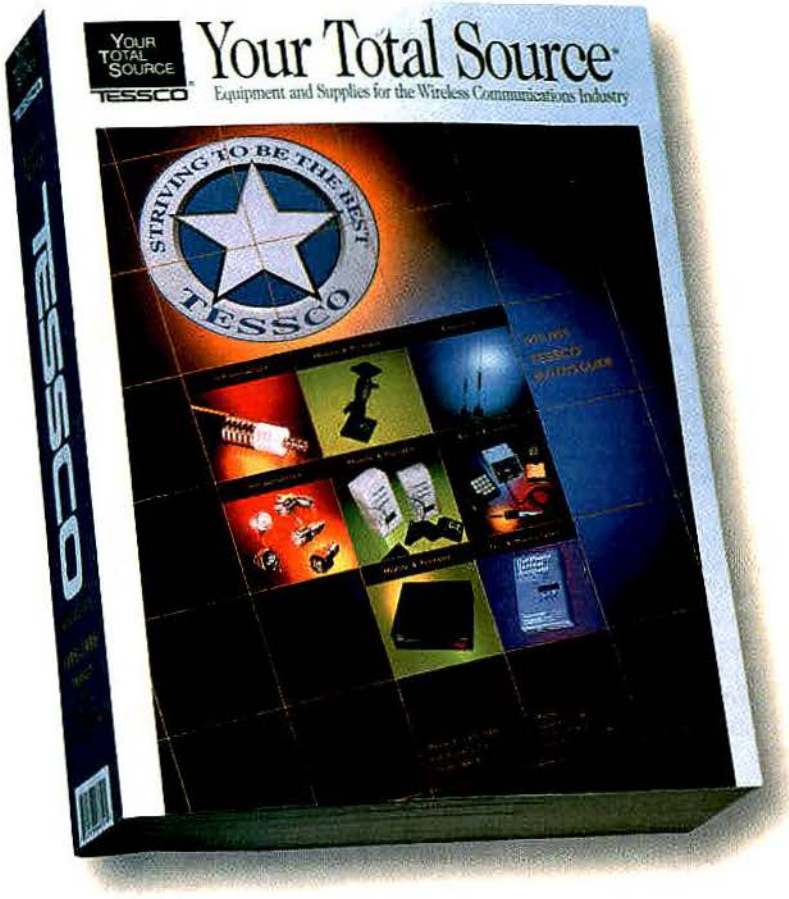

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Paging technology: Systems and services

Part 1—From simple alerting to voice storage, numeric and alphanumeric services, answer-back paging and computer linking, here is a look at the technology behind the fast-growing paging industry.

By Lynne Stewart

RF communications is one of the fastest growing markets in the world today. An integral part of this growth and success is the service offered to paging subscribers. Pagers were first used by business professionals, and the introduction of cellular telephone service raised concern that the pager market would decline. With the increasing use of pagers by all ages for both business and personal reasons, it seems more likely that there is a market for both types of communication and that subscribers will make the choice between the two based on cost and intended use.

The paging market is expected to continue its huge rate of growth, and because of this there is an increasing interest in paging technology. This article series will include an overview of paging systems and some of today's and tomorrow's paging formats. Functional blocks of a pager will be discussed, as will pager measurements and measurement techniques.

The pager

Pagers are designed to listen to one frequency channel. Information contained on this one frequency can be tone, voice or digital data. When the pager receives the identification signal, the pager beeps, vibrates or flashes a light to notify the subscriber that a paging message has been received.

Figure 1 above shows the most popular type of pager in use today, a numeric pager. It has a small liquid crystal display (LCD) that is capable of displaying 20 digits, typically the caller's phone number. Also shown is an alphanumeric pager. With this type of pager, the subscriber does not have to make a call to receive the message. Alphanumeric paging is becoming increasingly popular.

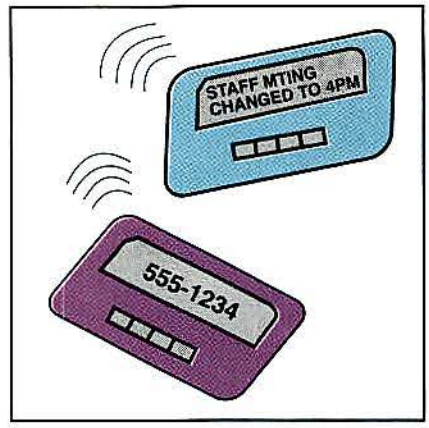

Figure 1. The most popular type of pager in use today is a numeric pager (bottom). Its liquid crystal display (LCD) shows as many as 20 digits, typically the caller's phone number. An alphanumeric pager (top) displays the caller's message, eliminating the need for a subscriber to call for details.

The first pagers were analog only, and each pager was assigned a separate frequency. Later, digital technology allowed many pagers to share one frequency. A single frequency could be coded in such a way that thousands—even millions—of pagers could share the same frequency without interfering with each other.

Where is pager technology going in the future? Two-way paging systems are now being released. With two-way paging, the receipt of messages can be acknowledged, and the subscriber can transmit a programmed reply to a received message.

Types of paging services

Paging services come in several forms:

- tone only.
- tone and voice.
- numeric.
- alphanumeric.
- computer interface.

Tone-only paging alerts the subscriber that someone wants to communicate. This type of service is most useful when the subscriber only needs to call one place, such as an office.

Tone-and-voice paging, the follow-up of tone-only, allows the subscriber to receive a voice message. Unfortunately, the voice message can be missed if the subscriber has the pager turned off or is out of transmitter range.

Numeric paging is the most popular in the market today. A caller dials the phone number assigned to the pager and then, using a Touch-Tone phone, enters the number of a phone for a reply. The numeric pager notifies the subscriber that a call has been received, for example, by a beep or vibration, and the subscriber can retrieve the phone number of the caller from the pager display.

An alphanumeric pager requires the caller to have access to an alphanumeric terminal or a message center that can send alphanumeric messages to the pager. This type of service is the most expensive, but it can be valuable if the pager subscriber benefits by having immediate information rather than having to call someone for it.

Paging network

Information is sent to a pager via a *paging network*. (See Figure 2 on page 28.) A paging network begins at the connection to the public switched telephone network (PSTN) or telephone lines. For example, the caller accesses one of three things:

- voice mail.
- a paging operator.
- a Touch-Tone telephone dial.

The resulting paging messages are

Stewart is a market development manager with Hewlett-Packard's Microwave Instruments Division, Santa Rosa, CA.

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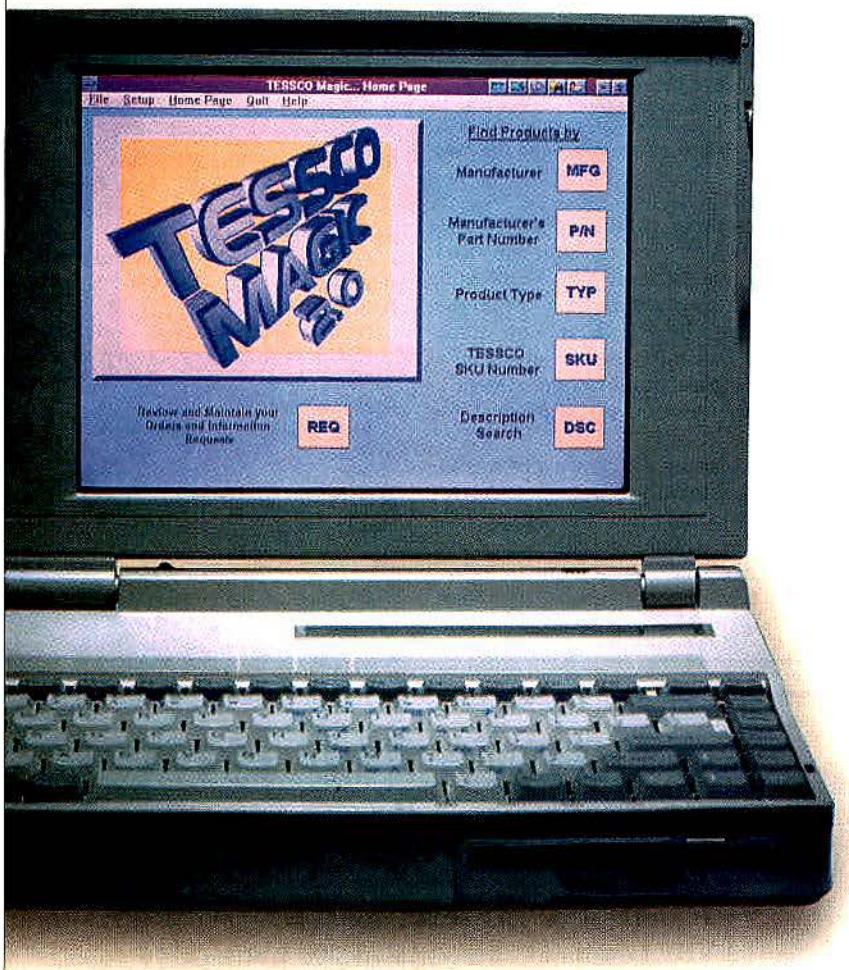

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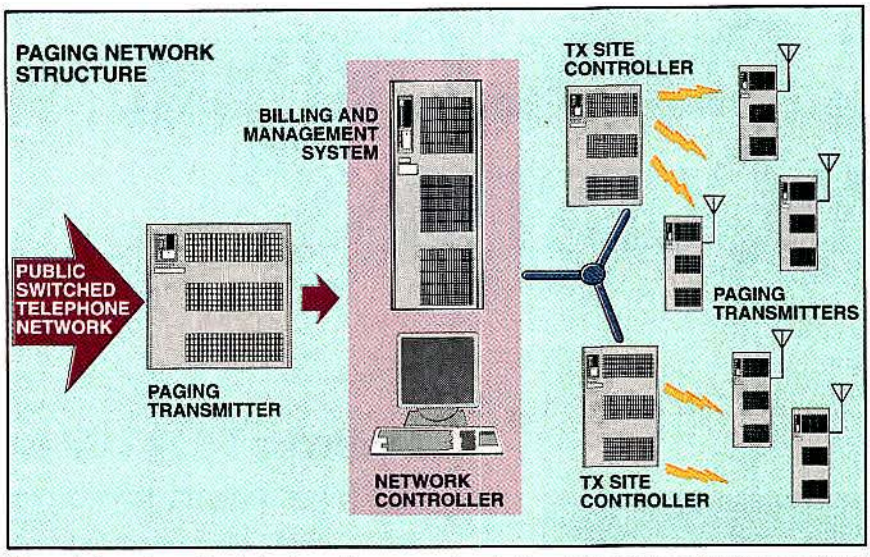

Figure 2. A paging network begins at the connection to the public switched telephone network (PSTN) or telephone lines. Paging messages are assembled in the paging terminal and sent to the network controller where they are combined into batches, based on their final destination. All billing and management is also controlled at this point. Transmitters then send the messages via radio to the individual pagers.

assembled in the paging terminal and sent to the network controller where they are combined into batches, based on their final destination. All billing and management is also controlled at this point.

Many paging companies cover more than just one geographical area. For example, the company may serve an entire state or country. The network controller specifies the site controller(s) for which the batched messages are intended and sends them out. Each site, covering a particular geographical location, may contain one or more paging transmitters. Once the site controller receives the batch of pages, it uplinks them to the paging transmitter(s), which then transmit the batch of messages at the same time on the same frequency using a simulcast technique. Simulcasting allows two or more transmitters to transmit identical information at the same time. It allows the system to provide seamless coverage on a single frequency.

There are many different types of paging formats currently in use today. Analog formats use a multitone (two, five or six tones) pager signaling sequence. These formats can transmit numeric information, such as phone numbers, or a voice. In addition to the analog formats, several digital formats are in use today. The most common, and the only worldwide standard at this time, is POCSAG, also known as RPC1. Others are Golay (a Motorola-proprietary format), NTT and NEC. Digital formats include Motorola Flex protocol, ERMES and RCR-43.*

The Flex protocol is receiving worldwide attention. Several successful field trials were performed in the United States and Flex products were introduced in 1995. The Flex protocol is being implemented in North America and soon will be in China, Indonesia, Singapore and Thailand.

ERMES is being developed mainly for use in Europe. Japan is working on its own paging format, RCR-43 which is based on the Flex protocol.

Next month: A focus on the digital formats.

*POCSAG stands for Post Office Code Standardisation Advisory Group.

RPC1 stands for Radiopaging Code No. 1, a designation of the International Radio Consultative Committee (CCIR).

Golay sequential code is named after Marcel Jules Edouard Golay (b. 1902), a physicist who constructed the code about 1955.

NTT is Nippon Telephone & Telegraph.

NEC is Nippon Electric Company.

"Flex" is short for flexible wide-area synchronous protocol.

ERMES stands for European Radio Message System.

RCR Std-43 stands for Research and Development Center for Radio Systems standard No. 43.

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Radio installation tips for fire fighting equipment

When installing communication systems in fire fighting equipment, early customer involvement in the process, planning and protection of interconnection wiring add up to a successful installation.

By Donald E. Koehler

Fire fighting equipment presents some of the greatest challenges to installers and technicians. This equipment can range from older pumper trucks, to super-size response trucks used at major airports, to multiple-story ladder trucks found in urban areas. In any case, the installer faces a variety of factors that need to be addressed for any communications installation to be successful. Planning is essential.

Part of the planning covers the type and location of operator interfaces such as control heads, intercoms, displays and keyboards. Once their placements are decided, location of the receive-and-transmit (R/T) units and cable routing can be determined. The problem of chafe can be addressed in planning. Chafe happens when wires rub against others in a harness or at attachment points. Once installed, especially in hidden areas, wiring problems can be difficult to trace, so to combat this problem, the installer can use spiral or cylindrical looming material to protect wires. Additionally, using care when wiring attachment points will help to reduce wear. Choosing rounded crossing points or strapping protective material around sharp edges will help to prevent chafe-related problems. (See Photo 1 below left.)

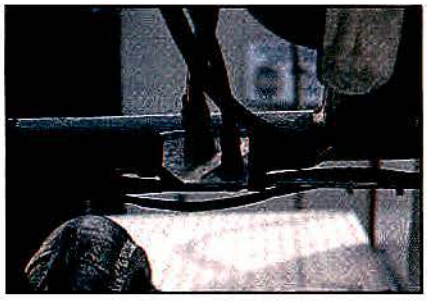

Photo 1. Avoid sharp edges on wire runs. Do not use installed hydraulic or air lines as support.

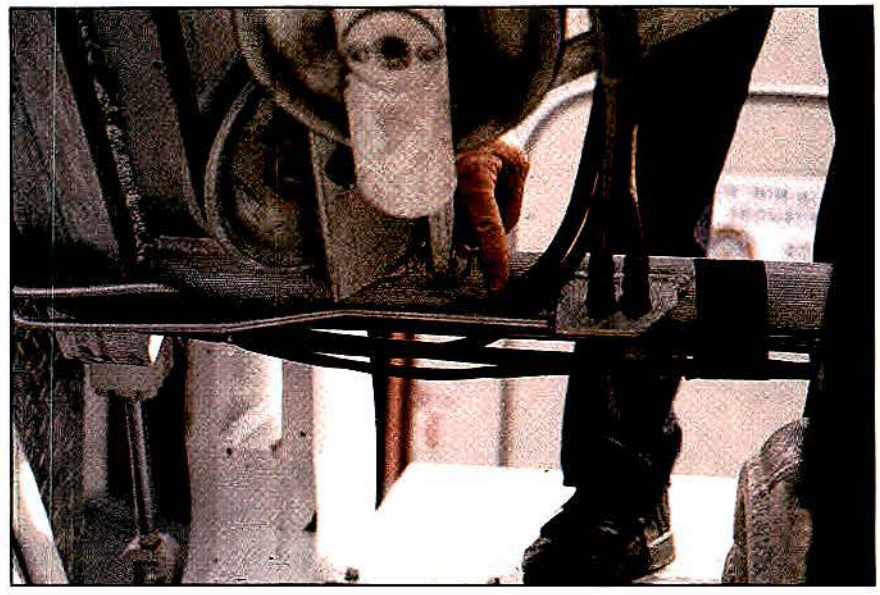

Photo 2. Make sure no one will have to step on wiring or cables.

When installing remote control heads or intercoms on ladder trucks, do not overlook hydraulic control lines or breathing air feed lines as guides for routing wires. Do *not* use these lines as a carrier by attaching the wiring directly to them. Use care, and avoid creating additional problems for firefighters with wire and cable unwisely placed. In Photo 2 above, the firefighter is pointing to cables that are placed where they cannot be stepped on as the ladder is used. Talk to the user as much as possible to learn what can and cannot be done in routing wire and installing equipment. Avoid splices on outside runs of wire because exposure to the elements is sure to cause problems.

Occasionally, "drip loops" may be useful in both keeping water out of connections and providing strain relief, especially in extremely cold climates. Connector "boots" or nonconductive sealants help to protect wiring and antenna cable connections from the water, foam and harsh conditions found on the job. If you use these coverings, be sure to include them as part of your periodic inspection program. Also, wiring and cables can become extremely brittle in cold weather, and the problem is magnified as the equipment leaves the warm station and heads into the cold. The operations crews can check some of these items as part of their routine maintenance, so get them involved. They can spot a small problem before it becomes a major repair effort.

Protecting communication system electronic units is important. In Photo 3 on page 12, the R/T unit is mounted on the

Koehler is the owner of Communication Specialties, Anchorage, AK.

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Photo 3. Many areas are useful for equipment mounting.

operator cab wall. This neat installation keeps the R/T dry and out of the way, avoids cable runs underfoot, and makes it easy for the maintenance technician to check or service the unit. The speaker is close to the driver, which is important in a high-noise area. Photo 4 below shows how important it is that all equipment operators be able to reach communication system controls while driving. If you are unsure, have the operator sit in the cab while placing the control heads. Do not forget that the operators wear gloves, so space the controls to allow extra room, if at all possible.

Antenna installation may take some thought. In Photo 5 on page 14, you can see the antennas installed on a super-size pumper used at a major airport. This mount setup keeps the antennas out of the way of the roof turret operator, provides a good ground plane and allows adequate clearance from objects that could block the signal while allowing access for maintenance

Photo 4. Check that operators can reach equipment.

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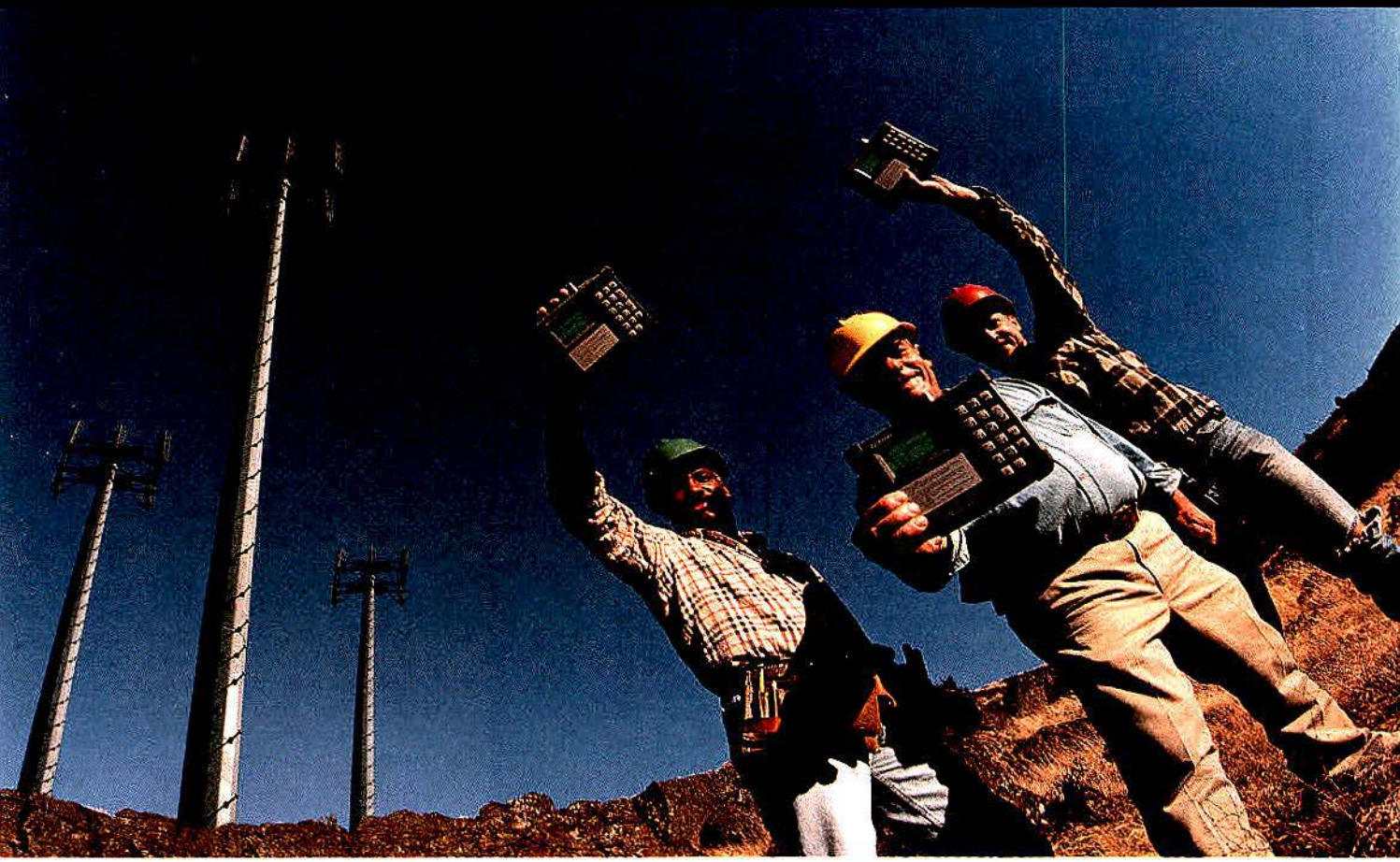

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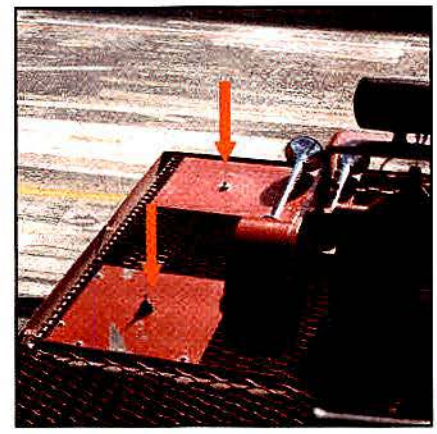

Photo 5. The placement of antenna mounts (arrows) should be planned to avoid problems with other equipment and vehicle operations.

and inspection. Agencies that require wide-area coverage should consider high-gain antennas or mobile amplifiers. Keep in mind that antennas are less expensive than amplifiers, and high-power output levels may cause interference problems. Alternate antennas, such as directional discontinuity ring radiator (DDRR), serpentine, glass-mount or vertical collinear arrays may be more appropriate for your agency. Take some time to look at antenna catalogs as part of the planning process. You may find some new ideas on vehicle mounts and innovative antenna designs. Call advertisers—most manufacturers and dealers are happy to answer questions and provide suggestions on how to fulfill your antenna requirements.

Customer involvement is a key factor in customer satisfaction. In talking with fire equipment operators in Anchorage, AK, I found that some original equipment manufacturer (OEM) communications equipment had to relocated because of accessibility problems. Planning with the customer in mind saves time and money. When installing communication systems in fire fighting equipment, early customer involvement in the process, preplanning and protection of interconnection wiring add up to a successful installation. Involve equipment operators in your periodic inspection and maintenance program to ensure continued, trouble-free communications as well as increased fire fighter safety.

My thanks to the men and women of the Anchorage Fire Department, Station 1, Ladder Truck 1, Shift C, and Public Affairs Officer Cleo. Additional thanks to Anchorage International Airport and Tom Eral, Bobbie Frisby, Rich Hittle and the rest of the professional crew working to make our lives safer.

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An introduction to mobile data networks

Use your applications provider as a sounding board and obtain a commitment regarding functions that it provides now and that it plans to provide as you define your network requirements.

By Dan Monopoli

Basic facts about mobile data (sometimes called digital) terminals (MDTs) can help public safety agencies to evaluate available options.

Protocols

In computer-science language, a *protocol* is a standard procedure for regulating data transmission between computers. This definition also applies to mobile communications. Each MDT network supplier has a protocol to control data flow across the network's radio frequency (RF).

It can be important to understand the basics of, and reasons for, a network supplier's protocol when selecting MDTs. Unfortunately, there is no universal standard protocol. Each RF services provider has its own "standard." You may be tied to an individual supplier for many years, because each supplier's protocol is proprietary, which means that only devices designed for use on that protocol will work.

Throughput and user control

Differences in protocols can affect system functions, performance and capacity. Two potentially serious limitations are *throughput* and *user control* over allowed applications. Throughput is the number of transactions that a network can carry over a single frequency. It restricts the number of active users who can use the MDT network *at the same time*. An RF channel is a single-thread pipeline, and it is the protocol that regulates the flow of traffic. "At the same time" is emphasized because only one device can actually communicate at a time; nevertheless, because the data are digital, information can be transmitted in a series of regulated RF bursts.

Dedicated data systems have *frequency pairs*. One frequency transmits from the base to the field units; the other transmits from the field units to the base. Some protocols actually prevent more than one unit from transmitting at the same time. Others will accept one incoming transmission and reject any others, therefore requiring an automatic retransmission. These differences affect a protocol's actual throughput.

System use, after all, is determined in part by the number of functions provided to the officer in the vehicle.

Computer capacity at both ends of the RF may influence perception of throughput; still, the protocol design imposes more serious limitations on throughput than does the hardware speed. Throughput may not be a significant issue if the number of active users per frequency is limited, or if the applications are restricted to conventional MDT functions.

Software control

An MDT's functionality is under software control. Know the origin of the software that controls the network and determine its flexibility to handle future needs. Some application vendors use third-party system control software that puts functionality in the hands of the system software vendor, who may not necessarily be the application vendor. Being locked into a vendor's protocol can be expensive when it comes to future hardware purchases, but being locked out of any say in the system control software functionality can make the purchase obsolete before it is even installed. System use, after all, is determined in part by the number of functions provided to the officer in the vehicle.

Dumb vs. intelligent terminals

The debate over dumb vs. intelligent terminals in vehicles continues, but just as there is no single computer or operating system that can meet the needs of all users, there is no simple choice between dumb and intelligent terminals, either. It really is a matter of desired functionality, durability and cost.

Selection criteria

An MDT, whether dumb or intelligent, is designed for long and rugged use. A department first purchasing MDTs does not necessarily need intelligent devices that cost thousands of dollars more per vehicle than dumb ones. Evaluate the department's desired functionality, how soon that functionality is to be achieved and the available budget to determine whether intelligent terminals are worth it. Intelligent MDTs, called *mobile computer terminals* (MCTs), typically cost thousands of dollars more than their "dumb" counterparts, but they have essentially the same screen display and font (character) sizes. Using dumb terminals improves productivity while reducing voice traffic by as much as 79%; yet if you will want intelligent functionality within the normal upgrade or replacement time cycle for your agency, consider initially purchasing intelligent terminals—if the budget allows.

Report writing

Report writing from vehicles often is stated as the big reason for considering whether to purchase MCTs. Many agencies have successfully eliminated as much

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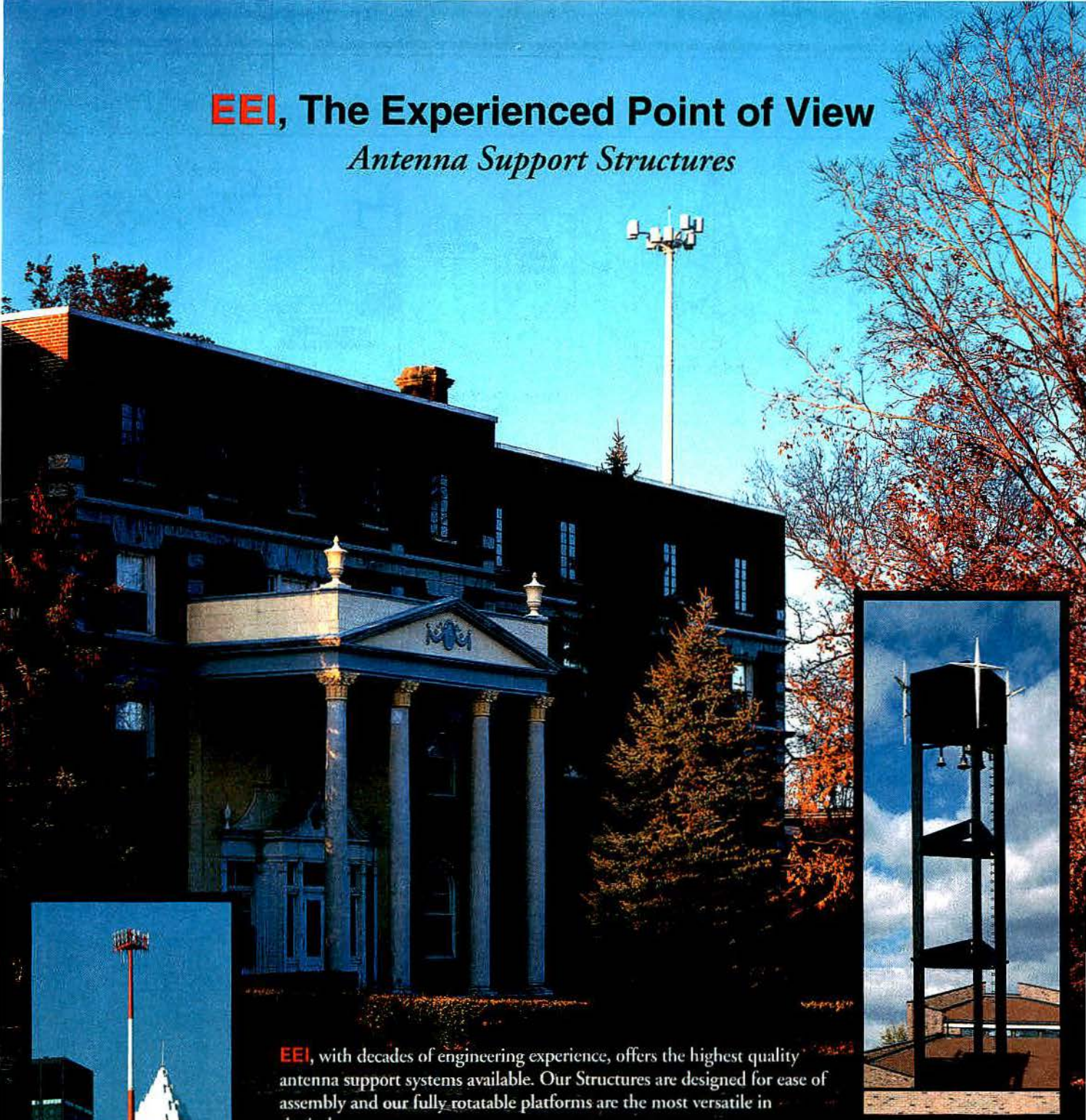

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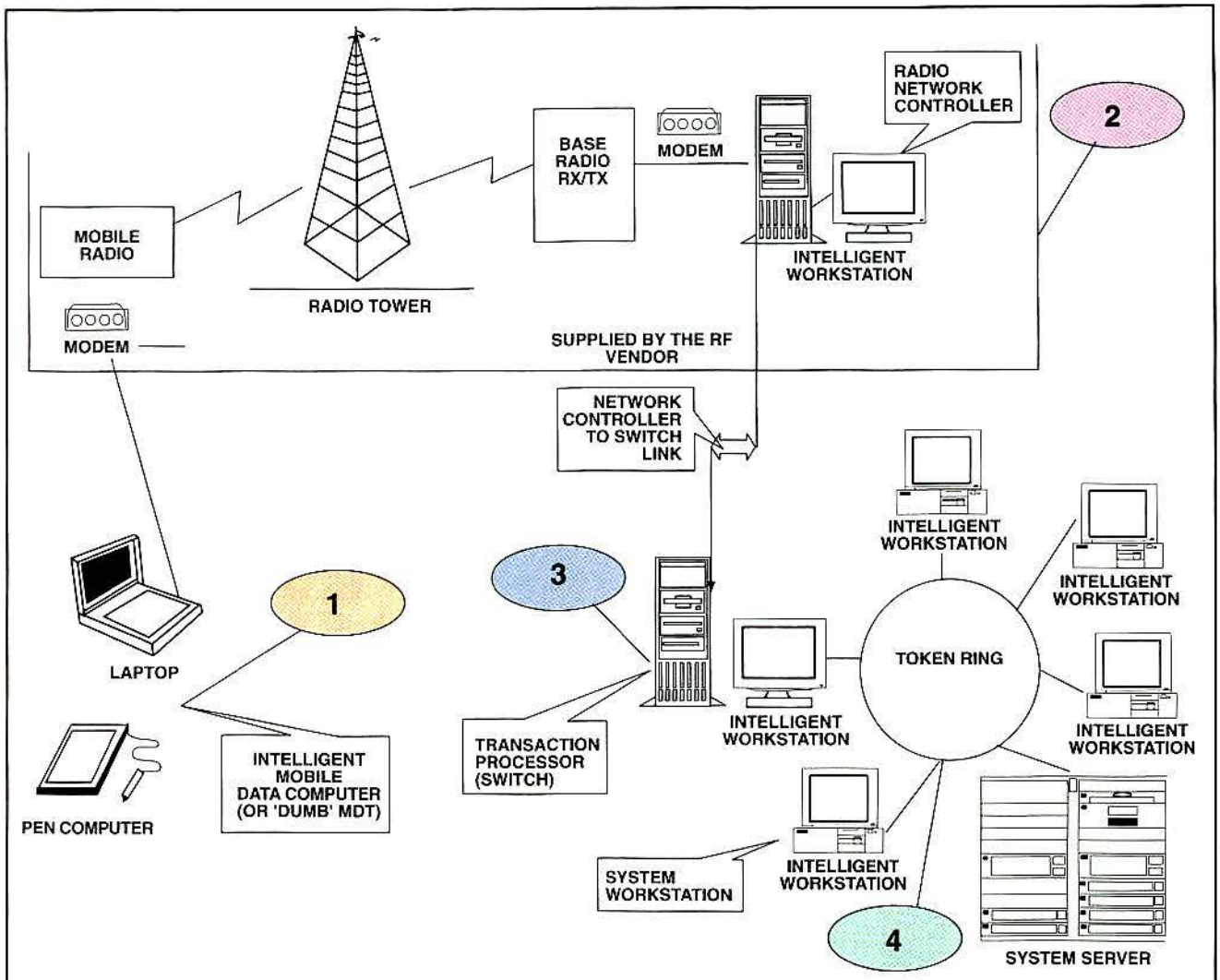


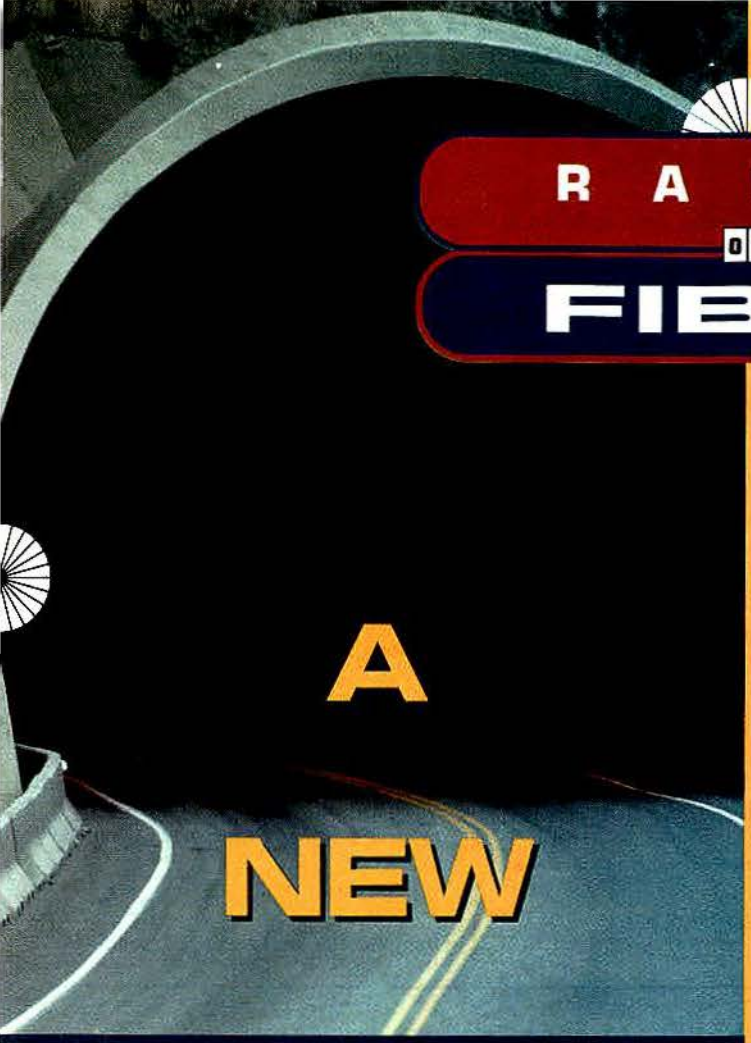
Figure 1. Four major components of a mobile data terminal system.

1 The mobile device can be a limited function terminal (LFT) or an intelligent mobile computer terminal (MCT). Proper selection depends on an evaluation of the functions your agency intends to provide to patrol officers. An MCT is required if needs extend beyond limited incident disposition from the field. One type of intelligent device to consider is a pen tablet. Pen-enabled application programs support incident and accident reporting. LFTs may be available only from specific RF vendors and may be limited to one or more dedicated protocols. If you select an LFT for the initial installation, be certain that the vendor supports an interface for MCTs as well.

2 The system's RF component includes a radio network controller that defines the protocol and the RF modems that must support the protocol selected. Protocol is not necessarily a negative word. The most important characteristic is the manner in which messages are handled, which may make different protocols incompatible; nevertheless, each company has designed its system to satisfy particular needs. It is important to understand the differences among protocols before selecting a vendor. In shared networks, the network controller usually resides at the vendor's facility. Your agency connects to the controller through dedicated telephone lines, a cost factor to consider in evaluating systems.

3 The transaction processor "attaches" the radio network controller to your computer system. It can be a series of programs that resides within your main computer, or it can be a separate computer designated to perform these functions. This device processes messages and requests from the mobile devices. Mobile functionality depends on the range of requests that this device is capable of processing. Know who developed the application and who is responsible for maintaining it. If your applications vendor does not support this software, future expansion of functions as technology advances may be limited or extremely expensive.

4 Ultimately, your mobile data system is an extension of your basic application system. It should provide the opportunity to reorganize work assignments by permitting field officers to perform more actions independently. Your application system must be capable of mobile integration to gain all of the advantages and efficiencies possible through the installation of a mobile data system.



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as 85% of their written reports by having officers dispose of an incident from the vehicle using so-called "dumb terminals." The training cycle associated with an MCT that contains reporting applications can be considerably longer than that for a dumb terminal. Consider whether the productivity gain will offset the additional investment.

NCIC 2000

The future plan for National Crime Information Center operations (NCIC 2000) assumes the ability to send fingerprint information, mug shots and other complex data over RF networks. These functions require intelligent devices. Determine whether your agency must comply with NCIC 2000 standards, sooner or later. Establish whether you are limited to a single large capital investment vs. an upgrade-and-replacement cycle that will allow you to replace the initial terminals on a suitable schedule.

Undoubtedly, intelligent devices are beginning to capture many departments' imaginations. The power of these devices provides a platform for innovation and opportunities, but it is important to consider the overall picture. Careful planning and consultation with the applications vendor can help to ensure that the capital investment is well-spent.

User functionality

This discussion covers some of the more common MDT functions and assumes the use of an MDT network connected to a computer-aided dispatching (CAD) system. The combination of MDTs and CAD provides the most powerful potential for increasing the productivity of an agency's patrol division since the introduction of vehicular two-way radios.

The combination of MDTs and CAD provides the most powerful potential for increasing the productivity of an agency's patrol division since the introduction of vehicular two-way radios.

Basic functions

The use of dedicated computer keyboard keys to notify the dispatcher about the mobile unit's status, to make state and national crime information center inquiries and to send messages is generally accepted as a basic MDT function. Using these keys can significantly reduce voice traffic, which is a recognized bottleneck in any agency.

Advanced functions

MDT functionality is enhanced by adding:

(1) unit and incident inquiry capability.

(2) incident disposition (report writing).

(3) access to local intelligence files, general data files and shift notes.

(4) access to local and county computer data.

(5) electronic mail.

Imagine the usefulness of sending a

message to an officer who is coming on duty later by having the message automatically downloaded to the officer's MDT when he signs on in the vehicle.

Automatic "hit" identification

As a matter of officer safety, the system should be able to notify the dispatcher when an officer initiates a traffic stop and receives a warning of a possible "hit" on the license plate that has been checked. In some systems, MDT functions are isolated from dispatch, in which case the officer must send redundant messages to keep the dispatcher informed of his activity. Obviously, a system of this type puts the officer in danger and should be avoided.

Network options

Rather than investing in a so-called "private" network, consider a semi-private network that your agency can join for a subscription fee, and then purchase the in-car devices. In all cases, these networks have limited functionality because the system's control is defined by the application software, not the hardware. One or more of the following network options may be available.

▶ *Subscription network* — Several subscription networks are available. For example, the Illinois Criminal Justice Authority (ICJA) recognized the need for a subscription network for smaller agencies. With this type of network, member agencies need not be concerned with infrastructure. ICJA installed base stations in selected populated areas and a central system control at its Chicago headquarters. ICJA has the software that provides system functions. Member agencies pay a modest user fee and purchase one or more in-car devices. ICJA provides the agencies with operating manuals and an access protocol that allows them to connect their private CAD system via telephone line to ICJA's central control computer.

Subscription networks such as ICJA's are subject to performance variations because of their design or intended use and therefore must be regulated; nevertheless, they provide a valuable service to many agencies that otherwise might be deprived of MDT functionality.

▶ *Shared infrastructure* — A controller can be used to allow multiple agencies using a CAD system to share a single MDT infrastructure. Each agency "sees" the system as private, but the controller allows inter-agency communication. It also allows the infrastructure cost to be shared. Because the infrastructure is shared, participating agencies must use the same manufacturer's hardware;

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still, the shared infrastructure can be a cost-effective alternative and a more efficient use of available frequencies.

▶ *Statewide network* — A CAD system and the control network for the first statewide mobile data network in the United States was provided in 1992. When completed, this system will permit any public safety agency in that state to subscribe to MDT services.

Two of the most significant advantages of this distributed processing design are statewide roaming and frequency balancing. With roaming, a vehicle can travel anywhere in the state and automatically communicate with its home base. Frequency balancing provides maximum system efficiency. Each district has at least two frequencies. Vehicles are assigned automatically to one or the other frequency to balance the load. In the event of a hardware failure, the second frequency also serves as a redundant path to provide uninterrupted communications.

Automatic vehicle location and MDT

In 1988, MDT and automatic vehicle location (AVL) functions were integrated for the first time. Previously, individual RF networks were used for each function. AVL data were "piggybacked" onto MDT messages, saving the cost of using separate systems. AVL installed with this technology, together with the reduced cost of the locators, makes AVL an attractive function for providing additional officer safety.

When the "piggyback" technique is used, AVL can add overhead to an RF infrastructure, depending on the system's polling frequency. This technique can add further sensitivity to the protocol efficiency and the number of active vehicles that can be supported.

With roaming, a vehicle can travel anywhere in the state and automatically communicate with its home base.

When considering an MDT network, make sure that the AVL is available from the vendor, and know its cost and implementation method before making a commitment.

Summary

As you contemplate whether to implement an MDT network, use your applications provider as a sounding board and obtain its commitment regarding functions that it provides now and that it plans to provide in the future. Get answers to the following questions:

(1) Is the vendor the primary supplier of the interface software?

(2) Does the vendor have the experience to demonstrate its competence?

(3) Is the vendor capable of supporting your current and future applications needs?

Most importantly, check references. Talk with similar agencies that have bought MDTs and use their experience to help you to plan and to implement a system that will serve your agency and your community successfully for years to come.

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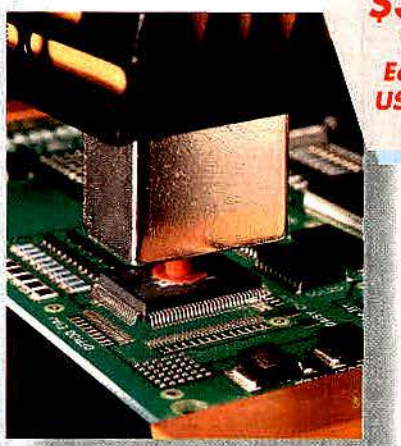

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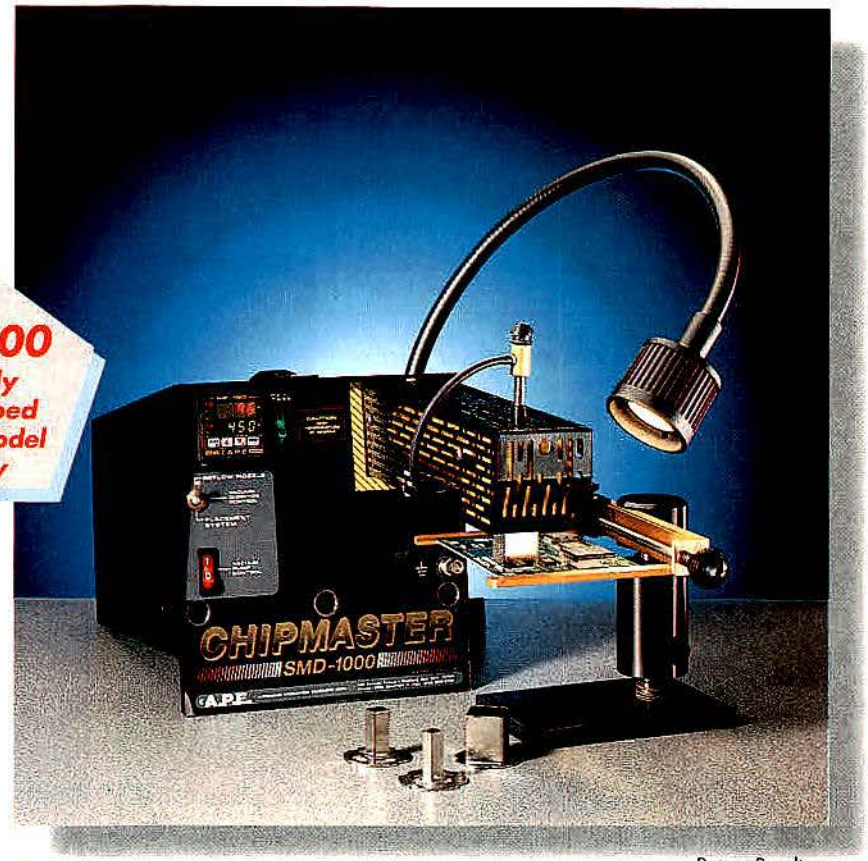

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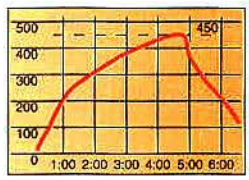

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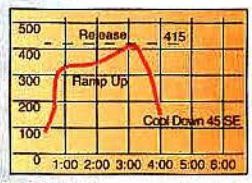

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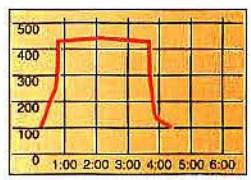

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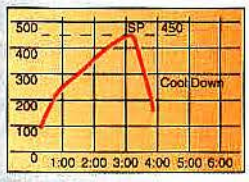

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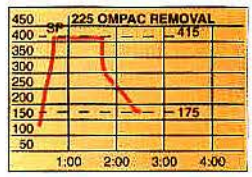

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The ABCs of communications towers

Determine initial and future uses for your new tower. Select a tower manufacturer and a tower installer with good reputations to protect the investment you make in the equipment. Inspect and maintain your tower regularly.

By Betty J. Pilar

Basic information about tower purchasing and installation will help you to communicate your requirements to a tower manufacturer, leading to better decisions and a smoother process from inception to installation.

General information

There are two basic types of towers, *guyed* and *self-supporting*. A guyed tower is a slender, steel structure supported by one or more levels of braided or stranded high-strength steel guy cables that anchor it to the ground. A self-supporting tower can be a three- or four-sided steel-lattice pyramid or box, or a tubular monopole.

One important consideration in selecting a tower is how much land (and of what type) it will occupy. A guyed tower needs much more land than a self-supporting tower because the guy cables usually are anchored to the ground at a distance from the base equal to about 80% of the tower's height. For example, a 250-foot guyed tower may require more than four acres, whereas a 250-foot self-supporting tower requires less than one acre. Soil types on the prospective property have to be suitable for supporting foundations or for holding guy anchors.

Cost considerations

Comparing the cost of towers requires an examination of an entire list of expenses, including materials, erection time, shipping and land requirements. The material expense for guyed towers typically is less than for self-supporting towers because less steel is used. Most foundations for guyed towers cost less than those for self-supporting towers because they usually are smaller, requiring less concrete. Because less steel is used, on-site construction time for guyed towers is generally less than for self-supporting towers. Guyed towers with 20-foot-long, solid-steel, prewelded sections can be erected even quicker than formed-plate guyed towers, further reducing erection costs, but they may be more expensive to ship because of their weight and volume. Although these comparisons may make one think that a guyed tower costs less than a self-supporting tower, that may not be the case—because of land requirements.

The cost of land may be a prime consideration. If the site is in a remote area where land is readily available and its cost is relatively inexpensive, the guyed tower would be more economical. If the site must be located in a developed area with premium land costs, a self-supporting tower may be more economical despite its higher material, installation and transportation costs.

Pilar is a sales representative at Andrew Corporation, Orland Park, IL.

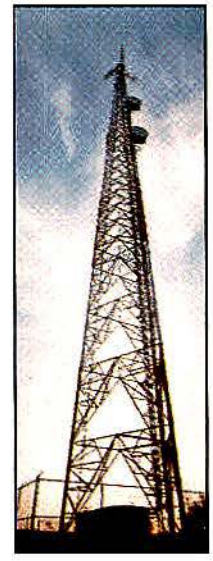

Photo 1 (left). All-bolted-construction, heavy-duty, guyed towers, such as this one with a 54-inch face width, can stand more than 550 feet high.

Photo 2 (right). This self-supporting pyramidal tower can handle heavy loads, and its steep taper allows it to fit where space is limited.

Maintenance

In general, annual inspection is recommended for all types of towers and should include checking the tower and antenna bolts, safety ladder, cable bridge, pressurization equipment, weatherproofing, lighting, grounding and foundation. Guyed towers may require more frequent maintenance than self-supporting towers, and the guy cables should be inspected for proper tension and to detect corrosion. Proper tension ensures that the tower is supported correctly and that there is minimal deflection of antennas caused by twisting of the tower. Guy cables are either stranded or braided and galvanized to prevent corrosion. Chipped or cracked bonding should be repaired. Self-supporting towers with tubular members require closer inspection for corrosion than those with angle members, where all surfaces are exposed. Some tubular members have "weep holes" drilled at the bottom to permit moisture drainage, and inspection should ensure that these holes have not been plugged.

Guyed towers

Guyed towers suit a wide range of loading conditions from light applications (including light-duty microwave, cellular and land mobile radio) to extremely heavy loading (such as heavy cellular, medium-to-heavy microwave, broadcast, and medium-to-heavy cable television and low-power television). (See Photo 1 above left.) The weight of ice and the stress of

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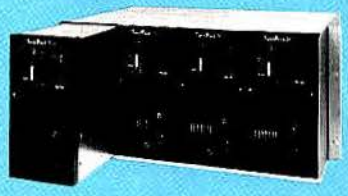

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Photo 3. This step-tapered monopole tower exposes less area to the wind, which results in reduced loads. The transmission line is protected because it runs inside the pole.

high winds also can contribute to heavy loading on a tower.

A guyed tower may be constructed of formed, high-strength, steel-plate, angle leg and bracing members that bolt together, or as all-welded, solid, round members that arrive in 20-foot, prefabricated sections. These sections bolt together quickly to reduce installation time and costs.

The "face width" is the measurement of each side of the tower structure. For example, if a tower is model M36, the width of each face is 36 inches. The larger the face width, the more structural capacity that is available for installing antennas, ice shields, and radomes.

Self-supporting towers

Self-supporting towers come in a range of custom-designed shapes with triangular or square footprints as well as a single pole (monopole). Towers with triangular footprints are generally preferred over those with square footprints because they are lighter and more economical to erect, and they have lower overall foundation costs. These towers fit lightweight applications such as cellular and mobile two-way radio, and they are practical for use where space is limited or costly. For heavy microwave applications, towers with triangular footprints towers can be designed to handle many antennas along with other loads such as ice shields, platforms, large antenna feed lines, wind and ice. (See Photo 2 on page 46.)

The single-pole self-supporting tower, usually referred to as a monopole, can be a tubular section design or a formed, 12-sided, tapered pole with an equal taper along its length. (See Photo 3 at the left.) Monopoles generally range from 75 to 150 feet high. Above 150 feet, the pole may be too large to be cost effective and may not provide the stability to keep some antennas aligned correctly under adverse conditions. Compared with other tower types, monopoles require far less land. They often are more acceptable to zoning boards because they are better-looking and less obtrusive in the skyline. They are typically used for cellular applications. Generally, monopoles are more expensive than latticed self-supporting towers.

Quoting a tower

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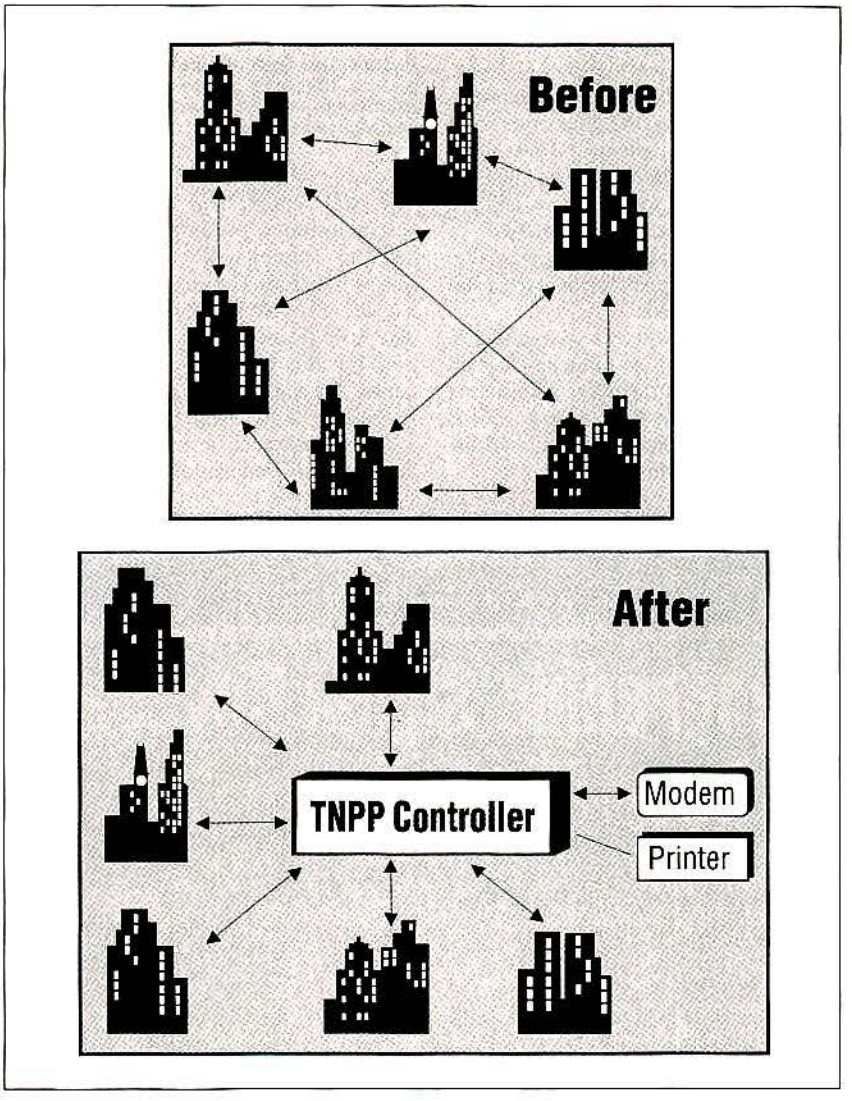

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and in the future), the next step is to contact manufacturers for quotations. The tower manufacturer needs several key items of information to provide you with useful quotations on a tower that will meet both your requirements and any restrictions, such as zoning codes or land availability. The most vital information you should supply is:

1. **Design load.** Use EIA/TIA specifications, the telecommunications industry standard design criteria, and note the revision level. These govern the tower unless local codes supersede them.

2. **Wind speed.** Sometimes referred to as wind load, this is the force the wind has on the tower and antennas. These measurements are predetermined for all U.S. counties in the EIA specifications and are stated in pounds per square foot (psf) or miles per hour (mph). For any given site, towers can be designed for heavier wind speeds than specified.

3. **Ice load.** Also known as radial ice, this is the amount of ice in inches formed around each tower member. Minimums are precalculated for various parts of the country, but the design can be altered for heavier icing conditions.

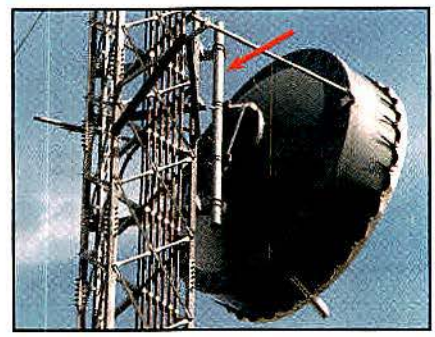


Photo 4. This antenna pipe mount (arrow) supports a 10-foot, high-performance, shielded microwave antenna on a 46- or 54-inch face width guyed tower.

4. **Soil report.** This report details the soil conditions present at the site and helps to determine what type of foundation is required. The engineering staff can use the EIA Normal Soil industry standard specification to quote on an installation, but this is strictly for a "budgetary quote" for a tower and foundation. When it comes time to design the foundation for a specific tower, an actual soil report must be provided. Foundation design is based on tower reactions and soil conditions. Independent geotechnical engineering companies usually are hired by the buyer to prepare the soil report. For convenience, most tower manufacturers can subcontract this service for an additional fee.

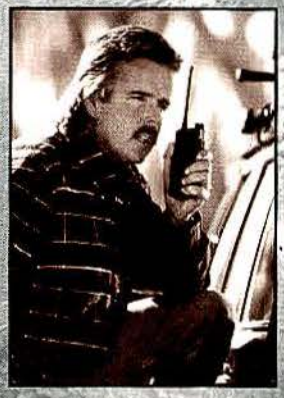
5. **Other design specifications.** Additional specifications might include Uniform Building Code (UBC), Building Officials and Code Administrators (BOCA), Southern Standard Building Code (SSBC), or specific government agency requirements in the area where the tower will be built. These specifications are in addition to the limitations stated in permits issued by the Federal Aviation Administration (FAA) or Federal Communications Commission (FCC). All codes will affect the factors used to determine loading requirements.

6. **Antenna loading.** Antenna loading covers anything added to the tower, initially or in the future, that will be exposed to the wind. At this step, it is important to think about what plans you have for the tower:

a. *Quantity.* Number of antennas, both initial and future installations.

b. *Models.* List of part and model

"Downtime can kill my business."



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numbers for antennas to be used. These numbers tell the tower design engineer the exact size, weight and frequency of the antennas to determine how rigid the tower must be.

c. *Size*. Diameter of each microwave antenna.

d. *Type*. Each type of antenna, high-performance, grid, cellular or broadcast, affects windloading differently.

e. *Elevation*. Placement on the tower of each antenna (feet above ground level).

f. *Azimuth*. Direction the antenna faces, usually in degrees. This aspect determines the placement of each antenna on the tower.

g. *Radomes*. Identification of the antennas that will have radomes (covers that protect antennas from dirt, wind, and ice).

h. *Coaxial cable and waveguide*. The kind of cable (foam or air dielectric) and/or elliptical waveguide and the sizes that will be used.

i. *Operating frequency*. Used to determine allowable twist and sway, especially on self-supporting towers.

7. **Other accessories.** Everything placed on the tower must be specified because added weight and windload will

Photo 5. A triangular platform (red arrow) and retractable side arms (white arrows) atop a pyramidal tower designed for light-to-medium loading.

Photo 6. Cellular star mount frames (black arrow) support directional, omnidirectional, and sectored antennas. Torque stabilizers (purple arrow) add tower twist protection to maintain critical antenna alignment.

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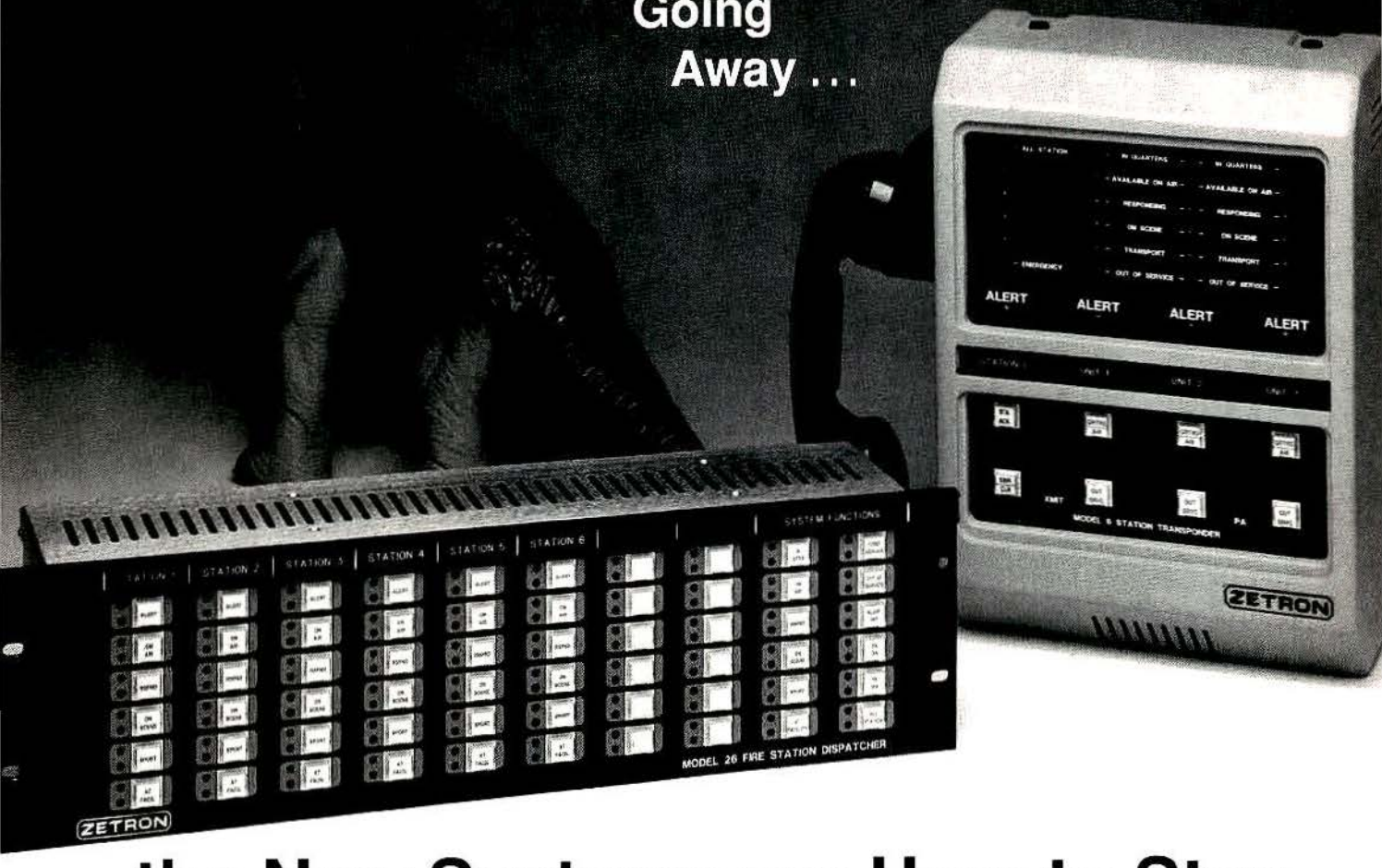

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affect the type and construction of the tower:

a. *Antenna mounts.*
b. *Platforms.*
c. *Side arms.*
d. *Climbing devices* (ladders, step bolts, safety climb devices).
e. *Paint* (shop or field).
f. *Lighting* (red light, strobe, or dual).
g. *Grounding* (EIA or special).
h. *Ice shields.*
i. *Waveguide bridge.*

Once all the tower information is compiled and submitted, engineers can develop specifications for both the tower and foundation and can help you with exhibits for the zoning processes. Exhibits might include one or more of the following:

- foundation design.
- site layout drawing.
- permit tower drawing packages.
- calculations and drawings for the foundation and tower structure bearing the seal of a registered professional engineer.

Photo 7. Ice shields (black arrows) are used to protect parabolic antennas, such as this one atop a heavily loaded microwave tower. The polymer-coated fiberglass radomes (purple arrow) also shed ice and snow to maintain the integrity of the antenna feed.

Tower site construction involves many steps: building an access road; bringing in electric and phone lines; erecting a fence and installing other security measures; providing and installing the equipment shelter; erecting the tower and installing transmissions lines and antennas; and testing alignment of all lines and antennas. Some tower manufacturers will provide a turnkey program that packages all of these services, or you may contract with different suppliers for the various services.

Putting up a tower is not difficult when you know what information you need and accumulate it up front. Start by deciding what you want to accomplish with the tower both at the initial purchase and in the future. Select a tower manufacturer that stands behind its design, materials and service. Give that company all the information you can. Select a reputable tower installer to protect the investment you make in the equipment. Finally, inspect and maintain your tower regularly.

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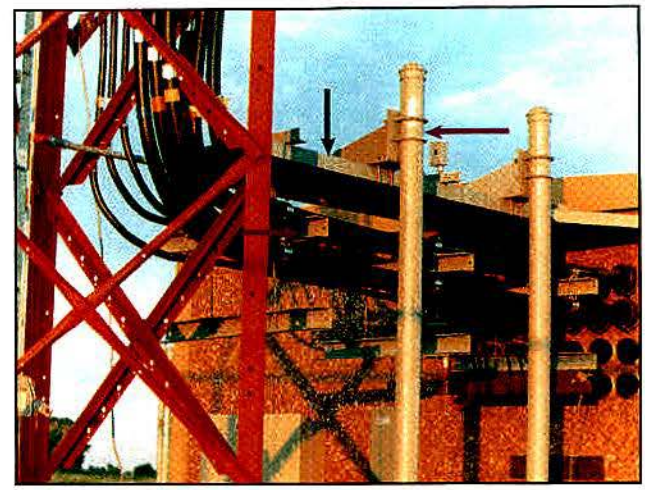

Photo 8. A waveguide bridge (black arrow) protects from four to 24 cable runs and is installed with a supporting system (purple arrows) of pipes and cable hangers.

GLOSSARY OF TOWER TERMS

The accompanying glossary identifies the terms most frequently used in purchasing a tower. Become familiar with them, and know which ones in particular affect the decision-making process for the tower you want to erect.

Antenna pipe mount A pipe used to mount an antenna to a tower. (See Photo 4 on page 50.) This mount should be ordered with the tower when microwave antennas are part of the initial installation.

Cable safety climb A safety belt and cable worn by workers when they climb the tower. A locking device, which travels along the safety cable, is attached to the safety belt to prevent the climber from falling.

Cellular antenna platform A square and/or triangular platform that provides a safe working environment for cellular antenna installation and adjustment. (See Photo 5 on page 52.) It also provides mounting support for antennas.

Cellular star mount A triplex frame that can support as many as 12 whip antennas with the other cellular antennas that are separated by 20 or 30 feet. (Photo 6 on page 52.)

Climbing ladder A ladder mounted either on the outside of a tower or internally such that two tower faces form a safety cage.

EIA Electronic Industries Association.

FAA dual red light/strobe system A kit of components needed to comply with FAA and FCC regulations. It consists of a combination of red light beacons and

sidelights that flash after dusk and white strobes that flash during daylight hours. The flashing strobe could be a nuisance to the surrounding populated areas at night, so less objectionable red beacons are used. No paint is required for the tower.

FAA strobe light system A flashing white beacon at the top. No paint is required for the tower.

Grounding system A series of copper wires and buried rods used to ground the tower, shelter, and transmission line. It is one of the most important deterrents to lightning damage. One lightning strike could bring the entire system down, resulting in a loss of revenue.

Ice shield A canopy installed directly above an antenna to protect it from damage caused by falling ice and other windblown debris. (See Photo 7 on page 54.)

Light controller A solid-state electronic device equipped with a photoelectric cell that turns tower lights on and off. Alarms indicate beacon, sidelight or power failures.

Paint A paint that adheres to galvanized steel. Painting is typically done in the field; however, factory applied paint is also available. The FAA requires that towers 200 feet and taller be painted and/or lighted. Towers shorter than 200 feet may require painting and/or lighting if they are near an airport. Painting consists of seven equally

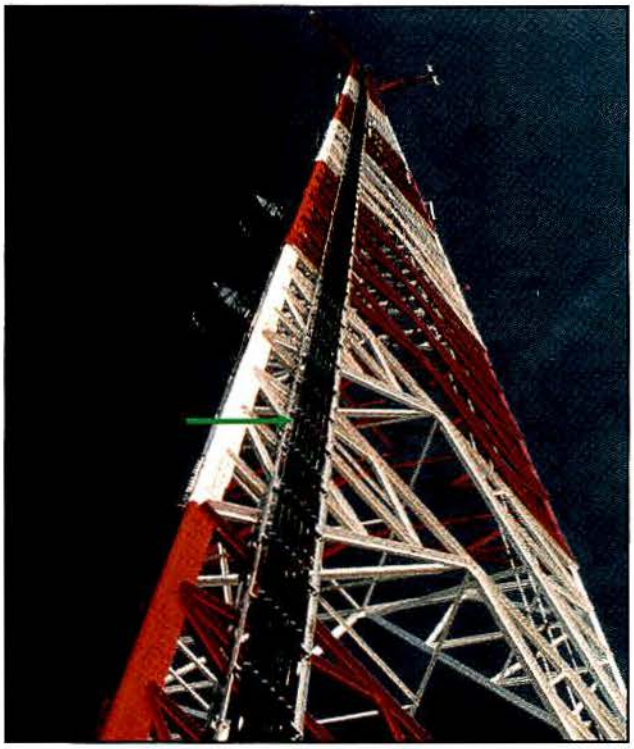

Photo 9. A waveguide ladder (arrow) supports six runs of waveguide on an SST. The waveguide ladder on a guyed tower is shown in Photo 1.

spaced bands, three of aviation white and four of aviation orange.

Radomes A cover installed over the antenna to protect the antenna and feed from accumulation of ice, snow and dirt and to help reduce wind loading. There are two basic types. Flexible planar radomes are stretched across the front of shielded antennas. They are made of either hypalon-coated nylon (lasts 5 to 15 years) or a polymer-coated fiberglass fabric (lasts 10 to 30 years). (See Photo 7 on page 54.) The radome flexes slightly in the wind and thus sheds ice and snow and protects the antenna feed. The second type is a molded or formed radome, usually made of fiberglass or plastic. These radomes are parabolic (dishlike) or cone-shaped and are attached to the rim of the reflector. They also provide protection to the feed even in severe environmental conditions.

Side arms Extensions from a tower that increase the clear distance between the antenna and the tower to minimize the interference created by the tower structure (See Photo 5 on page 52.)

TIA Telecommunications Industries Association

Torque stabilizers An assembly of extended arms used on a guyed tower to help prevent twist. (See Photo 6 on page 52.) They are generally attached above or below a microwave antenna.

Tower analysis A computer-generated report used to design new towers, to determine the modifications necessary to an existing tower before the addition of antennas, transmission lines, or accessories, or to change the height. Without a tower analysis, nothing should be added to a tower structure that was not specified in the original design.

Waveguide bridge A cover installed between the tower and shelter to protect the transmission lines from falling ice or other debris. (See Photo 8 on page 56.)

Waveguide bridge/support system A system that supports the transmission line between the tower and the shelter entry ports (openings in the building where the cable enters). (See Photo 8 on page 56.)

Waveguide ladder A support system designed to attach the transmission line to the tower. In a guyed tower, this support system is usually built-in. It consists of diagonal braces (with prepunched holes to accommodate hangers), which replace support diagonals at certain intervals. Waveguide ladders are also available for self-supporting towers. (See Photo 9 on page 57.) These supports bolt directly to the tower bracing for mounting transmission line without angle adapters or special brackets.

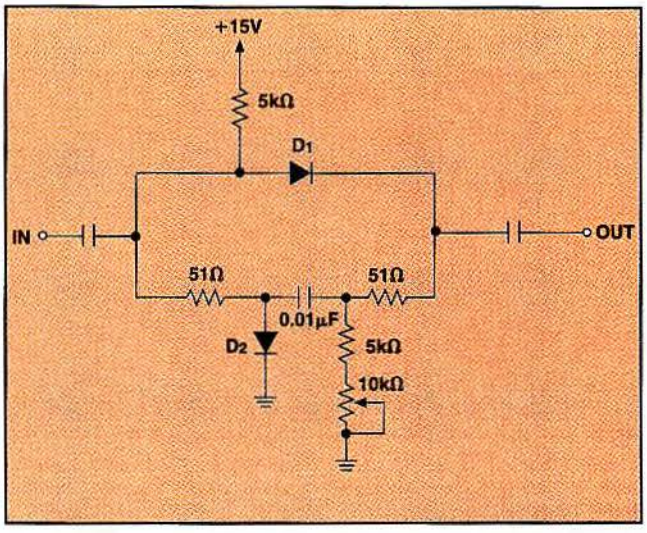

Figure 3. A broadband bridged-T attenuator with PIN diodes.

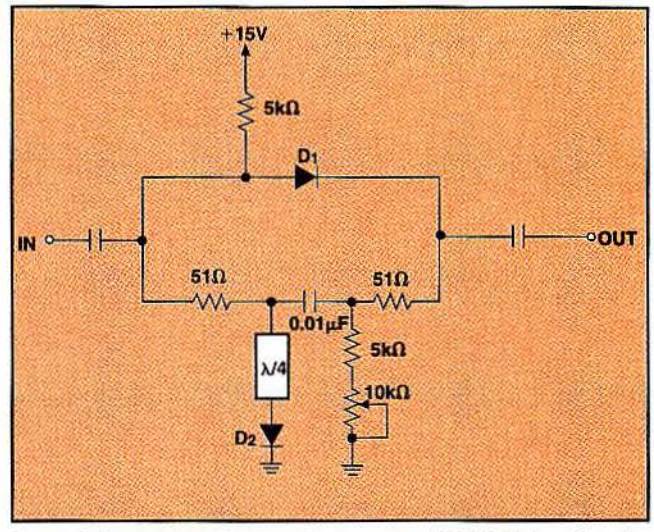

Figure 4. A narrowband bridged-T attenuator with PIN diodes. Note the quarterwave section of transmission line in the leg of the attenuator.

(continued from page 8)

allows the signal from the antenna to reach the receiver virtually unattenuated.

□ *Broadband bridged-T attenuator.* Figure 3 above left shows a broadband bridged-T attenuator. With a high bias current through PIN diode D1 and a low bias current through PIN diode D2, the attenuation of the bridged-T network will be quite small. With a high bias current through D2 and a low bias current through D1, the attenuation of the bridged-T network will be extremely high. Thus, by varying the amount of control bias to the two diodes, the attenuation of the bridged-T network can be set to any desired level. This is a broadband attenuator because there are no frequency-sensitive components in the network.

□ *Narrowband bridged-T attenuator.*

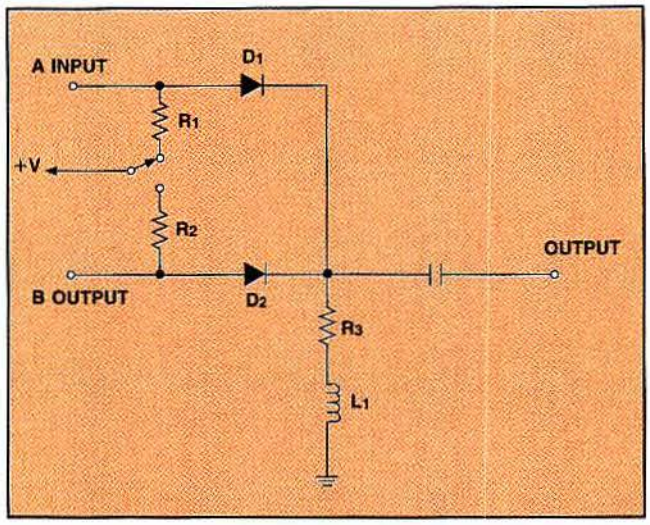

Figure 5. (left) This simple A/B input selector switch uses two PIN switching diodes.

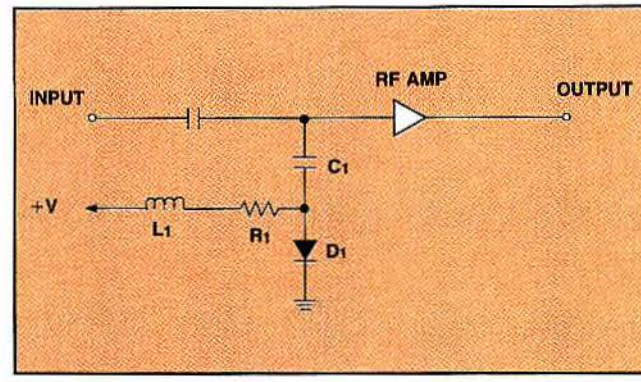

Figure 6. (above) This circuit allows the control voltage to set the attenuation by changing the shunting effect of capacitor C1 across the input to the RF amplifier.

Figure 4 on page 59 shows a narrowband bridged-T attenuator. It is similar in operation to the broadband bridged-T attenuator shown in Figure 3, except that it contains a quarterwave section of transmission line in the leg of the attenuator. This makes the attenuator narrowbanded because the quarterwave section of transmission line is frequency-sensitive.

□ *A/B switch.* Figure 5 above left shows a simple A/B (RF input selector) switch that can be built using PIN diodes. The switch can be located some distance from the circuit being switched. For the "A" input to be active, diode D1 must be forward-biased, and for the "B" input to be active, diode D2 must be forward-biased. R1, R2, R3 and L1 are part of the bias circuit for the PIN diodes.

□ *Simple shunt attenuator.* Figure 6 above right shows a simple shunt attenuator using a PIN diode. As the +V is increased, the forward bias on D1 increases, thus reducing the RF resistance of D1, effectively placing capacitor C1 in shunt with the input to the RF amplifier. The higher the bias current, the lower the resistance of D1, and the more shunting effect C1 has on the input of the amplifier.

Summing up

As you can see, using the PIN diode is simple. It can be used anywhere RF switching is needed. Just think of the PIN diode as a variable RF resistor, the resistance of which varies with forward bias.

Problems with PIN diode switching circuits usually are caused by bad components in the biasing circuit or a defective PIN diode itself. Dc voltage, RF voltage and ohmmeter checks are the normal methods of troubleshooting PIN diode switching circuits.

'Til next time—*stay tuned!*

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The spectrum and loan scandal

By Robert H. Schwaninger Jr.

Has Charles Keating been paroled from Allenwood or whatever country club prison he was sent to? You remember Mr. Keating, don't you? He's the guy who embodied the worst of the savings and loan scandal that only cost the American government and millions of investors about 17 squillion dollars. I'm just wondering if he got out and is sitting in some halfway house running this industry with the help of Big Mike Milken and Ivan "The Terrible" Boesky.

If you look at what's happening, you've got to wonder whether the telecommunications industry is heading down the same path that Chuck Keating took the S&L industry. The parallels are quite disturbing. What is even more unsettling is that, unlike the people ruined by Keating's kiting of loan deals, this industry doesn't have an FSLIC for small investors.

Before the feds put the brakes on Keating and his clones, what was happening was this: S&L guys would get in cahoots with local business types and find a plot of raw land. The best land was stuff that was essentially worthless, but had a really nice view of some major highway. The business types would then get an architect to draw a building or complex or high rise or something that looks good in ink and watercolor that supposedly was to be built on the raw land.

Armed with the pretty picture, the business guys would create a corporation, like Fleece Inc., and get an option to buy the land from Farmer Brown, who had used it to graze cattle for so many years that even stinkweed wouldn't grow there anymore. Then with the picture and the option, Fleece Inc. would create a prospectus that showed that if Fleece Inc. had the financing, it could turn the raw land into a gold mine. The prospectus would be nicely bound, filled with really interesting numbers and graphs and projections that proved beyond a doubt that the world was anxiously awaiting the first 12-story Jiffy Lube.

If Keating had been a banker instead of a stinker, he would have thrown the board of Fleece Inc. out the first time they showed up with the flip charts. But Chuck had other plans. With a wink and nod, he tossed his depositors' money at one deal after another, ignoring the fact that the hope of getting a return on the investment was about as good as Cleveland's hope of keeping the Browns. Why? Because even if the depositors weren't making a dime on the deal, Chuck was enjoying his role as the mover 'n' shaker behind these big deals.

What's all this got to do with our industry? Well, in place of raw land, read "radio spectrum." Radio spectrum is a lot like raw land. Standing there, it's just a platform upon which one builds a business. So what's it worth? Really, nothing. Then, how come it shows up in the book value of publicly traded corporations as an extremely valuable asset?

If you look over the records of many speculative corporations that are producing land mobile services, you will discover that spectrum is assigned a value, either directly or indirectly. It may be buried as megahertz per pop or channels per subscriber per exclusivity factor per something else, but it's there, and it is used to value the assets of the corporation for determining the value of shares of stock. In fact, some publicly traded corporations assign a rather high value to spectrum as compared with its valuation of the remainder of its assets.

Once spectrum is used to prop up stock prices, the value of spectrum becomes a talisman for the board of the corporation, held high in totem-like fidelity before financial institutions, and raised to a level that shadows the fact that the corporation simply doesn't make a profit. It obscures the fact that the service offered by the company is simply unprofitable. The fact that the company is unprofitable is politely ignored, like an ugly child. One simply doesn't comment that this multibillion dollar corporation is trying to sell a bad product to an unwilling public.

This polite treatment is aped by analysts who recommend buying the stock of these overvalued concerns to small investors. Investors, trusting the alleged expertise of the analysts, then buy the stock, assuming

Schwaninger, *MRT*'s regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

Regulating technology

that the corporation's newest fax/page/radio/video/interactive/digital/shortwave/longrange/whatsit will be a hit in the market, content in the knowledge that they are getting in on the ground floor of the newest wave of technology. But, as must certainly occur, one day the analysts turn on their investors, and without uttering a single mea culpa, declare that, lo and behold, this company ain't making any money. It's just spending money raised by stock sales and bond sales and financial red tag sales.

Like the walls of Jericho, the stock price comes a tumblin' down, and thousands of little investors lose their shirts, with no federally backed insurance plan to offset the loss. Meanwhile the company scrambles to stop the bleeding, because the board members sold their share months ago and they don't want to be embarrassed by the huge profits made right before the common stockholders took a bath. "Just a coincidence," they declare in harmony.

If the company is lucky, it will find a big investor that will buy a huge block of equity and give the appearance of stability to the company's value. With that dough in its coffers, the company will quickly turn around and try to find more radio spectrum to throw into its asset pool so that it can point to it and say to the analysts, "See, we got more so we're worth more. Tell people to buy our stock again." Sadly, many of the analysts will, once again ignoring the fact that the company still hasn't made a dime of profit and its chances haven't gotten any better. And a new group of small investors are lured into the pool for another big bath.

Although I could name a half-dozen companies that mirror the above examples, I've decided that I don't want to spend all of this year in court. Companies like this breed lawyers like bad cheese breeds mold. Besides, if you think about it, you could probably name a few with no help from me.

As an industry, we should be aware of the threat that these entities bring. They siphon off important financial resources that could be applied to legitimate technological progress. They spend enormous sums on lobbying Congress to auction more spectrum to prop up their alleged values. Their voracious appetite for spectrum to warehouse results in a chilling of the marketplace so that legitimate providers of services cannot obtain additional spectrum to grow and thrive. Their scads of applications piled atop the FCC staff become an unspoken justification for pushing administratively efficient operations that value quantity of greed over quality of service to be delivered to the public.

The American public is being duped. It's buying billions of shares of stock that are value-based on raw spectrum, pretty pictures, and questionable projections. The federal government is being duped. It is searching for ways to auction spectrum to feed the appetite of these companies, mouthing the false projections of the RBOC wannabes and their claims of emerging technologies. Everyone is headed toward the bright lights, like suckers to the Vegas Strip, and no one's quoting the odds. And the stampede is trampling the small, honest operator that has to make a profit or be out-of-business and bankrupt.

No matter how many shares of stock a company sells and no matter how many channels a company has and no matter how many auctions in which a company has been successful, sooner or later every company has to make a profit to survive.

This isn't to say that large, legitimate companies don't exist. They do, and their contribution to the health and opportunity available in the telecommunications industry is well felt. But the temptation to make a quick buck by fleecing small investors seems to be growing in the hothouse of the FCC's auction agenda. Perhaps its time to turn down the heat and let in some cold reality. No matter how many shares of stock a company sells and no matter how many channels a company has and no matter how many auctions in which a company has been successful, sooner or later every company has to make a profit to survive. And all the industrial policies, legislative agendas, and Wall Street hype can't change that fact.

So before people begin comparing Chairman Hundt to Charles Keating, right before the FCC becomes a division of the RTC, our industry would do well to examine the direction in which some members are moving and ask whether, over the long run, is it better to promote good products, valuable technology, honest profit and noble labor, or a fast buck?

News

PCS Development signs agreement with Westlink Paging

PCS Development (PCSD), Greenville, SC, has signed a memorandum of understanding with Westlink Paging, San Diego. Under the agreement, Westlink Paging will offer PCSD's advanced messaging services in 88 markets within 14 Western or Midwestern states when these services become commercially available in the first half of 1997.

PCSD, which is one of only five companies that own paired nationwide 50kHz-50kHz inbound-outbound narrowband licenses, is developing a seamless, nationwide digital network to deliver advanced two-way voice and data messaging services for business applications and the personal messaging market. Combined with PCSD's other affiliates, the relationship with Westlink gives PCSD the ability to reach 6.5 million subscribers in the United States. PCSD will begin beta trials of its mobile messaging services in Atlanta during the first quarter of 1996 and will conduct additional beta tests in Boston during the second quarter.

Based on Motorola's InFlexion high-speed, high-capacity voice and data protocol, PSCD's voice messaging service will deliver messages in the caller's voice to a pocket-size device, which can store as many as four minutes of messages. PCSD will also offer enhanced alphanumeric messaging service that offers a guaranteed delivery and acknowledgment of message receipt.

Nextel moves to Seattle area

Nextel Communications, Rutherford, NJ, will relocate its corporate headquarters to the greater Seattle area. The search for headquarters has begun, and the first relocation phase is expected to be completed by the end of this quarter. About 250 people will work at the new headquarters, which will be called the National Support Center. Nextel has said that it will ensure that any employees displaced by the relocation will have access to job opportunities across the corporation, as well as a full range of assistance.

JBro celebrates 20th anniversary

February 1996 marks the 20th anniversary of JBro Batteries. Originally founded as a provider of replacement batteries for the paging and mobile communications industry, JBro now offers advanced design rechargeable batteries, as well as custom production for the OEM market. JBro occupies two state-of-the-art facilities located just outside of Chicago and Houston. JBro is a licensed participant in the Rechargeable Battery Recycling Corporation program for environmentally sound collection and recycling of NiCd batteries.

Mathews forms division for telecommunications site selection services

The Mathews Company has launched RCM Site Acquisition Services, a new site selection and acquisition division to serve the telecommunications industry. The rapid introduction of digital communications technology, coupled with the recent federal government auction of telecommunications frequencies, has created the need for hundreds of tower sites in every metropolitan area of the country, said Catherine P. Collins, president of the new division.

Three public safety fleets choose Trimble GPS/AVL products

Public safety fleets in Aurora, CO, Monterey, CA, as well as a paratransit organization in San Jose, CA, have selected GPS-based automatic vehicle location products from Trimble Navigation, Sunnyvale, CA. The systems are used to locate, manage and dispatch vehicles for enhanced operations.

Mangonia Park, FL, chooses Landmark Type 1 tower

A Landmark Type 1 tower was recently erected in Mangonia Park, Palm Beach County, FL. This 519-foot, self-supporting tower was purchased from Landmark Tower, Fort Worth, TX, by Tower Works, a facilities designer group. The tower will be used for two-way communications, radio and TV.

Manitoba selects CML for province-wide E9-1-1

Manitoba Telephone Systems (MTS) has awarded a contract to CML Technologies, Hull, Quebec, Canada, to supply a province-wide E9-1-1 service for the Province of Manitoba. The contract covers an ECS-1000 central office E9-1-1 selective router/controller, PC call-taker positions and an HBF ALI database, as well as systems integration. The CML selective router was chosen because it has the flexibility to grow from one remote PSAP in the city of Brandon to providing E9-1-1 services to the suburbs surrounding Winnipeg and remote towns in the northern region of the province.

Readers' choice

Of all the new products and services in the June 1995 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Software walks users through FCC applications requiring Form 600

Brown and Schwaninger has created the *Form 600 Made Painless* software system that enables users to complete and print any applications that use FCC Form 600. The software automatically converts feet to meters, or miles to kilometers, and assists in converting NAD 27 geographic data to NAD 83. The software also automatically fills in many of the questions consistent with the type of application being filed. Users may print a report that will identify possible missing or incorrect entries in their application. The printed product is your application to the FCC and can be stored on disk for future use.

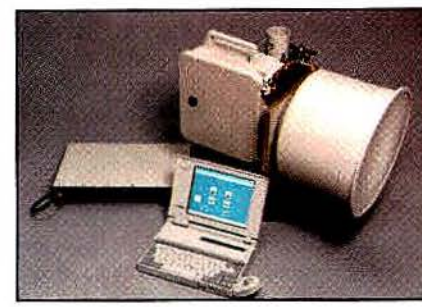
Circle (500) on Fast Fact Card

Software allows dual operation, control of Johnson base stations

Pacific Circuit Design has developed new PC software to allow dual operation and control of E.F. Johnson LTR 8605 base stations. Features include multiple system operation, automatic programming of system and codes from the dispatch screen, and individual or group identification.

Circle (401) on Fast Fact Card

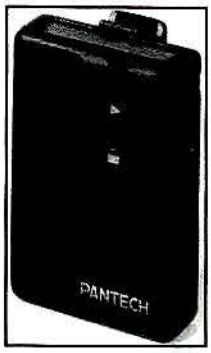
'Smart' microwave radio provides common platform, management links

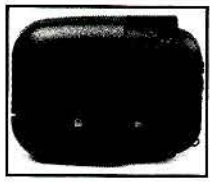


The Spectrum II radio from **Digital Microwave** provides a common platform for applications across multiple frequencies and capacities. A synthesized frequency source and a wide-range power supply are incorporated into every radio. Software allows the user to set the radio's frequency channel during installation and to modify system settings through a Windows-based program. The software also links to the DMC Net network management system.

Circle (402) on Fast Fact Card

Canned alphanumeric messages relate musical score to page alert



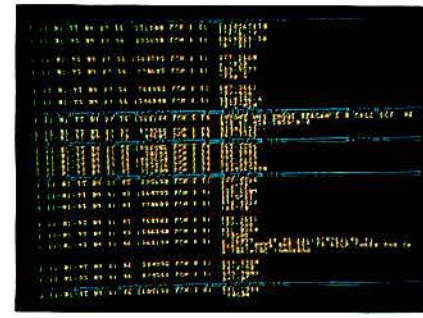


The Epic and Score numeric digital display pagers from **Pantech America** allow the caller to select and send canned alpha messages to the pager with each message accompanied by a related musical score. Recognition of the tune alerts the pager owner where to call. The model PT-103-Score pager (above left) is a numeric display pager for VHF only. The model PT-105 Epic pager (above right) numeric display pager is for both VHF and 900MHz. Both models include selective message delete, message save, message freeze, duplicate message detection and a low-battery indicator.

Circle (403) on Fast Fact Card

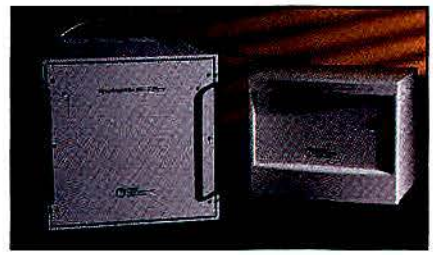
Paging decoder/system analyzer interprets Flex paging format

The Interceptor paging system analyzer and decoder from **Statistical Control Systems** recognizes Motorola's Flex paging format. The ac/dc portable unit features simultaneous operation on as many as eight channels for monitoring link and output frequencies, uplink and downlink frequencies or any paging frequencies. All models interface with just two wires to any FM radio, pager, receiver/scanner, service monitor, dial-up modem, 202T modem, link receiver, satellite receiver, or directly to a paging terminal, without level adjustments.



Circle (407) on Fast Fact Card

Cellular preselector filters reduce A-carrier interference to B-band



Illinois Superconductor has two ultra-high performance preselector filters for use by U.S. cellular B-band operators in high-capacity, harsh RF environment cells. Model Q50K-BN6 contains six notch filters to reject interfering A-carrier mobile transmissions between 845MHz and 846.5MHz. Model Q40K-B2 contains dual integrated passband and notch filters for B-band operators using diversity receive operations. Both filters offer low insertion loss and dramatic adjacent band signal rejection improvements.

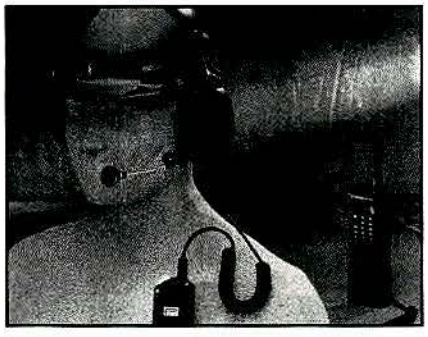
Circle (408) on Fast Fact Card

Billing software package processes ESAS-format SMR trunking records

IDA offers an SMR billing software package that is capable of processing records created in the ESAS trunking format developed by Uniden. The software creates invoices for dispatch, interconnect and long distance phone calls. Charge rates are flexible and can be varied according to volume, time-of-day and individual customer ID. As many as 999 cell sites can be processed. A built-in conversion feature allows processing of downloads from non-ESAS sites as well as downloads from equipment from many different manufacturers.

Circle (404) on Fast Fact Card

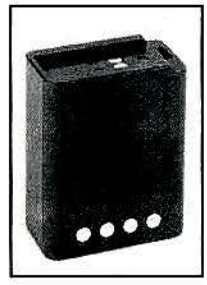
Noise-attenuating RF, hardwire headsets offer boom or throat mic option



Peltor offers lightweight, comfortable, noise-attenuating headsets and adapters for VHF, UHF and hardwired communication systems. These headsets are available with a choice of boom or throat microphone and are offered in a variety of styles: overhead, backband and hardhat attachments. The adapters and push-to-talk switches are available for most VHF and UHF radios on the market.

Circle (405) on Fast Fact Card

Rechargeable replacement battery matches several Uniden radios

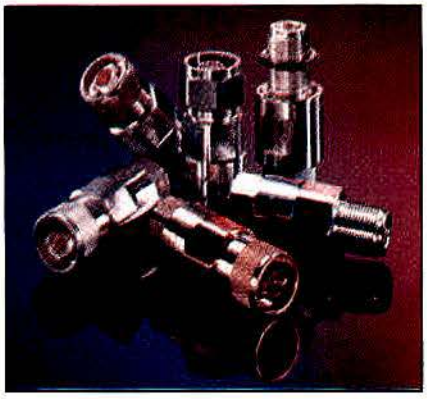


The JB-1100 7.2V, 1,200A rechargeable battery from **JBro Batteries** is a direct replacement for the Uniden APX-1100 and fits both Uniden SPS310 and SPS320 radios. The battery is manufactured to OEM specs for performance and reliability.

Circle (406) on Fast Fact Card

New products

Self-flaring connectors require fewer tools, less installation time



Self-flaring Type N connectors from **Andrew** are for both ½-inch foam and ½-inch superflexible foam cables. These connectors reduce installation time and costs in comparison to tab-flare connectors. Fewer tools are required because the design allows an installer to automatically flare the outer conductor when the body is threaded together, thus producing a more consistent flare and ensuring better electrical performance. Both solder and captivated (solderless) versions are available.

Circle (409) on Fast Fact Card

Antenna offers a 30dB isolation solution for UHF interference

Samco Antennas' SAM-410/H horizontally polarized, omnidirectional base and mobile antenna offers a solution to UHF interference problems. It provides as much as 30dB isolation from vertically polarized UHF transmitters. The unit minimizes interference during remote broadcast because of high isolation factors between vertical and horizontal polarization. The antenna is available for frequencies between 400MHz and 512MHz with a maximum bandwidth of 15MHz.

Circle (412) on Fast Fact Card

Spectrum analyzer boasts more than −95dBm sensitivity, accessories

The PSA-65B portable microwave spectrum analyzer covers frequencies from less than 1MHz to 1,250MHz and has greater than −95dBm sensitivity. The lightweight battery- or line-operated unit from **AVCOM of Virginia** offers several accessories: the BNG-1000A tracking (noise) generator for doing swept measurements; 1,250MHz wide frequency extenders; the RFP-24 preamplifier for increasing sensitivity to less than 1μV; and the LPA-1000 log-periodic antenna.

Circle (410) on Fast Fact Card

System melds cellular with GPS for vehicle monitoring, security

Transportation Management Systems has added the Secure-Trac AVL system to its Auto-Trac AVL product line. The system was developed for vehicle security and uses GPS for navigation and the cellular network as its communications link to a central monitoring location. The system consists of an in-vehicle tracking unit and a Pentium-computer-based control center that monitors the location, speed and direction of a vehicle as often as every five seconds. A visual icon of the vehicle's tracks is displayed on street-level maps at the control center. Features include a covert battery backup,

panic button, listen-in device, door lock/unlock system, RF keyring panic alarm, vehicle alarm interface, fuel system cut-off and a detachable handset.

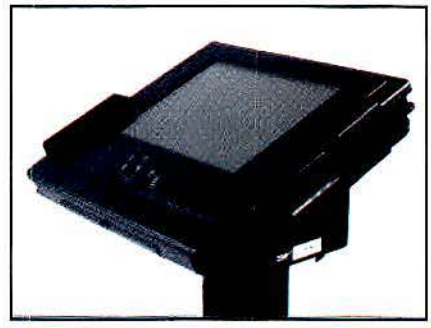
Circle (413) on Fast Fact Card

Portable radio sports 'I-beam' diecast frame, rubber gasketing

The PS-series portable radios from **Pantech America** allow the user to switch from 5W to 2W of RF power in both VHF and UHF models. An "I-beam" alloy diecast frame separates the radio's RF section from its control section. Rubber gasketing incorporated into all channeling on the diecast frame housing provides environmental integrity equated to MIL STD-810. Each radio has as many as 16 channels with built-in CTCSS and DCS, as well as selective channel scan, priority scan and all scan. Standard features include battery save, busy channel lockout and delayed TX.

Circle (411) on Fast Fact Card

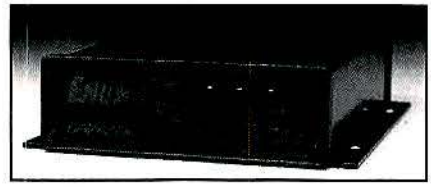
Quick-release mount system works with Epson pen-based computer



The VMEP4 custom mount system for the Epson EHT400 pen-based computer uses a key lock that allows quick installation and removal of the computer. The mount also features two security tabs that wrap around the edges of the computer. These tabs offer protection and discourage theft without hindering access to any peripheral ports. The mount can be used with any of **SMC Electro-Mount's** S2000 line of computer mount supports.

Circle (414) on Fast Fact Card

Multiplexer adapts EDACS radios for data peripherals, imaging



The Emux mobile digital multiplexer from **Dataradio** adapts Ericsson EDACS radios for data. The Dataradio Multiplex Protocol (DMP) allows as many as three serial devices, such as terminals, bar code readers and printers, to share a single EDACS radio. Other supported data applications include imaging software for public safety. The unit also features an intelligent GPS port. In addition to the DMP mode, the Emux can be configured for RDI applications.

Circle (415) on Fast Fact Card

Remote includes parallel status indication, programmable text strings

Model 280 from **Zetron** is a programmable, eight-frequency EIA-compatible digital tone remote. Parallel Status Indication makes the remote ideal for situations where multiple units share the same base station. When an operator changes the status of the base station, that change is displayed on all parallel model 280s. Text strings may be programmed into the remote, which are words that appear in the LCD to inform the operator which frequency has been selected. The unit has programmable function keys, and the configuration can be saved on diskette and uploaded onto parallel remotes. The remote can be equipped with a built-in paging encoder for two-tone, five-tone, DTMF and alert paging.

Circle (416) on Fast Fact Card

Export model hand-held transceiver offers variety of signaling formats

The HS2000 "Sector" from **Macaw Electronics** is a hand-held transceiver offering CTCSS, DCS, ANI and 5W of power output. The unit uses microprocessor and synthesizer circuitry. All electronic assemblies are securely mounted in a die-cast metal frame and enclosed in a durable, impact-resistant case. The HS2000 is offered for export only.

Circle (419) on Fast Fact Card

Protective clothing complies with RF radiation exposure standards

Now recognized as a viable means of complying with RF radiation exposure standards, Naptex RF protective clothing from **Maxwell Safety Products** is ideal for almost any maintenance environment. Naptex serves the telecommunications industry in areas recently determined to have potentially hazardous levels of RF radiation. Roof-top cellular and paging base stations can be a haven for high levels of RF radiation to anyone in the vicinity of the antennas. Naptex provides a high degree of safety and security, reducing the levels of radiation, as well as liabilities at the site.

Circle (417) on Fast Fact Card

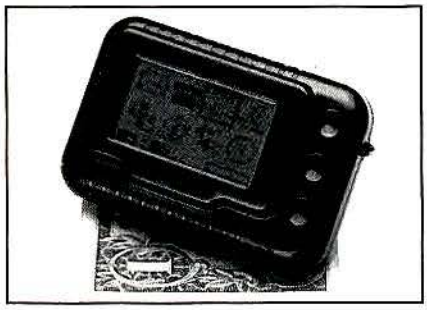
Alarm relay monitors single, multiple tower lamp failures

The **SSAC** SCR-630T universal lamp alarm relay for 230Vac systems senses lamp failures on radio towers and other tall structures. The unit detects the loss of one out of four 500W flashing beacons or 116W side lamps. A torodial transformer constantly monitors current flowing in the lamps' wiring. Two outputs are available to operate a spare lamp or an alarm. The relay operates on 230Vac 50H/60H, with encapsulated circuitry for protection from the environment.

Circle (418) on Fast Fact Card

New products

Alphanumeric pager performs several database, computer functions



AirTrak is an alphanumeric pager with an on-board computer. Messages appear on a bitmapped, backlit LCD, which allows the unit to peform computer functions, store information into separate databases and display graphic images. The pager from **Radio Computer & Telephone (RC&T)** is available in 148MHz–152MHz and 929MHz–932MHz bands with channel spacing of 25kHz. Users can choose 64K, 256K or 512K of data storage. In addition to the page databases, others may include notebook, calendar time scheduler and E-mail. Graphic icons on the screen identify the databases.

Circle (420) on Fast Fact Card

Hand-held frequency counter uses digital filtering, data capture mode

The pocket-size CUB frequency counter from **Optoelectronics** is designed for communications and surveillance applications. Features include a digital filter to reduce false counts, auto capture, 10-hour battery life and eight selectable gate times. A capture mode allows for a frequency to remain displayed as long as desired without being overridden by surrounding RF.

Circle (421) on Fast Fact Card

Panel antennas feature rugged design for high-density cell sites

The panel (PA) series microcell pole or low-profile building mount antennas from **Larsen** are constructed of laminated, closed-cell foam with precision-cut radiating elements. Designed for indoor or outdoor applications and for high-density cell sites. All panel applications feature a VSWR of <1.5:1 TX, vertical polarization and a front-to-back ratio of 20dBi minimum half-power beamwidth. The antennas are available in single-element, dual-element and quad-element.

Circle (422) on Fast Fact Card

Monitors' design focuses on true, continuous power measurement

Loral Microwave-Narda's CellGuard family was designed for continuous, true RMS power measurement of complex composite signals and VSWR monitoring of TX antennas in SMR, cellular and PCS applications. Four full-function models are available. Each includes all the display, alarm and communications features of the CellGuard series.

Circle (423) on Fast Fact Card

Battery-powered strength meter covers wide range of frequencies

The Champ from **Berkeley Varitronics Systems** is a portable, battery-powered signal strength meter that weighs less than five pounds. Users can select form models covering a wide range of frequencies: PCS, paging, IVDS, LMR, ISM and Flex. The unit is convenient for finding RF "shadows" in indoor wireless systems or for drive-around studies to detect RF leakage and propagation coverage. It features a built-in, 8-channel differential GPS; fast-charge circuit; PCMCIA memory system; capability to input X and Y coordinates from a floor plan; and odometer input for correlation to footage during drive-around studies.

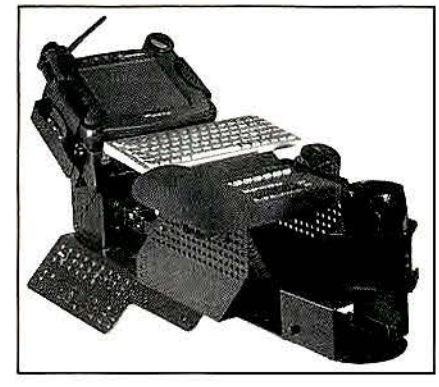
Circle (424) on Fast Fact Card

Hand-held workstation includes integrated modem for data network

The Ranger from **Melard Technologies** is a hand-held workstation with a fully integrated Ericsson M2190 wireless modem for connecting to Mobitex wireless data networks such as the one operated by RAM Mobile Data. The workstation supports four PCMCIA slots and is available with a 16MHz/20MHz 386SL microprocessor upgradable to a 33MHz 486 microprocessor.

Circle (425) on Fast Fact Card

Console mount supports Motorola Forté CommPad for patrol cars



The SDI 7200 console mount from **Scientific Dimensions** supports the Motorola Forté CommPad. The mount allows for easy installation of the EIA shock- and vibration-tested mobile docking station for the Forté, and it allows for easy use of all the features of the wireless communication device, such as keyboard swivel, rotation, removal and tilt functions. The mount also supports a range of optional equipment designed to meet the operators' safety and comfort requirements. The unit is compatible with all major police fleet vehicles, as well as a variety of other recent automotive makes and models.

Circle (426) on Fast Fact Card

Literature

Guides allow cross reference of cables, connectors

Three connector-to-cable cross reference guides are available from the RF Connectors Division of **RF Industries.** The three guides cover Belden, Alpha and Times Microwave cable and allow the reader to quickly determine which RF connectors are available for each cable.

Circle (301) on Fast Fact Card

Communications product catalog contains no pricing

Antenex has released a user version of its catalog with no pricing. The new version is available to the company's resellers and is good for use in a dealer's showroom or waiting room and for use with large end-users or export accounts. Featured are portable, mobile and stationary base antennas for two-way radio, cellular and data telemetry applications. Other products include mounting and cable assemblies, noise suppressors and various antenna accessories and installation tools.

Circle (302) on Fast Fact Card

Guidebook addresses attorney billing abuses

The *CEO's Guide to Managing and Controlling Attorneys, Legal Costs and Litigation Risks* from **Pickering, Bell & Major** contains more than 30 pages of tips, techniques and tactics for combating rising legal costs, as well as surviving the anti-business, anti-defendant bias found in the legal system today. The company's "Manage and Win Litigation Control System" offers owners and top managers of mid-size industrial, commercial and financial firms a clear and concise practical framework for immediate action to control legal costs and risks.

Circle (303) on Fast Fact Card

Buyers' Guide includes warranty, shipping information

The 1995-96 edition of **Tessco's** "Your Total Source" Buyers' Guide consolidates the offerings of more than 170 manufacturers, giving full side-by-side product descriptions for more than 13,000 wireless communications products. The 1,000-page guide includes product descriptions, warranty and shipping information and item pricing. All new items are highlighted for easy location, and tabbed sections cover infrastructure, mobile and portable accessories, antennas, bench equipment and supplies, and test and maintenance equipment.

Circle (304) on Fast Fact Card

Data sheet covers modulation analyzer

A two-page data sheet on the Model 8201 modulation analyzer has been released by **Boonton Electronics.** The literature provides a complete description of the analyzer, including specifications, operation and applications. Charts are included as well to aid in the description of the modulation analyzer.

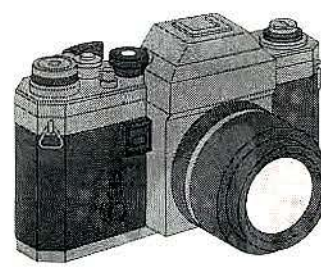
Circle (305) on Fast Fact Card

PCS-Scorekeeper to track PCS market development

The PCS-Scorekeeper is a map-based information source designed to keep the wireless industry informed on the progress of the PCS buildout. The sourcebook, developed by **PCIA** in cooperation with EDR, is divided into two major sections: the Geographic Strategic Planner and the Company Strategic Planner. Information is provided on market ownership for both PCS and cellular operators along with PCS buildout percentages. Included is a 3' × 4' national wall map illustrating auction winners at a BTA level. National PCS/cellular coverage maps for each broadband PCS operator are also included.

Circle (306) on Fast Fact Card

Do you have a photo you would like to see on the cover of *Mobile Radio Technology?*



We are interested in photographs of facilities, installations or other graphic material relevant to the audience we serve. We welcome material from vendors, consultants, dealers, technicians, service-providers, end-users and others.

If you have a 35mm slide, transparency or other piece of art that you think would be worth consideration for our cover, please let us know. We would love to hear from you!

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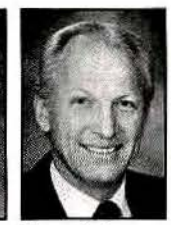
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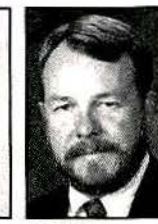
Nichols

Steve Shelton leaves Larsen Electronics, Vancouver, WA, as director of sales and marketing to join Kenwood Communications, Long Beach, CA, as national sales manager.

Glenn W. Marschel departs First Financial Management as vice chairman and chief operating officer for the financial and health care businesses to join PageNet, Dallas, as president.

Bill Edwards exits Centigram, San Jose, CA, as vice president of sales in the Enhanced Services Group to join Glenayre Technologies, Charlotte, NC, as vice president of sales and marketing for the Voice Systems Division.

Stephen A. Nichols leaves BK Radio, Lawrence, KS, as general manager of the Bendix/King mobile communications division, to become director of marketing for Burnsville, MN-based E.F. Johnson's radio communications division.

Alan Stewart, previously senior vice president of international sales and managing director of the Digital Radio SBU at Transcrypt International, Lincoln, NE, joins Phoenix Wireless Group, Maitland, FL, as vice president of business development, Asia Pacific markets.

Eric Baumann leaves E.F. Johnson, Burnsville, MN, as director and general manager of telemetry and custom products to become vice president of sales for Transcrypt International, Lincoln, NE.

Paul Kammayer departs Meridian Communications, Calabasas, CA, as site manager to join Diablo Communications, Richmond, CA, as director of operations.

Changes at EnBloc, Portland, OR:

William Stephens leaves Scientific Imaging Technologies, Beaverton, OR, as chief executive officer to become president of EnBloc.

Robert Broughton exits NEC America, Melville, NY, as senior engineer/hardware-software project leader to join EnBloc as vice president of research and development.

Ruby Alonso departs Telular, Wilmette, IL, as regional manager of sales and marketing to join JRC, Fort Worth, TX, as international sales manager.

Linwood Little exits NetBase as vice president of sales and marketing to join Subscriber Computing, Laguna Hills, CA, as vice president of sales and marketing.

Joe Watts, product training manager for Kenwood Communications, Long Beach, CA, advances to product manager for the land mobile radio products group.

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The journal of mobile communications technology

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Professional services

Category Index

Computer Software	pg 84	Professional Consulting Services	pg 72
Employment	pg 72-74	Professional Services	pg 71
Equipment For Sale	pg 74-82	Rentals	pg 71
Equipment Wanted	pg 82	Repair Services	pg 84
Manufacturer's Reps	pg 72	Tower Services	pg 71
Pager Repairs	pg 82	Tower Space	pg 70-71
Paging	pg 82-83		

Classified

Professional consulting services

Manufacturers reps

Employment

TELECOMMUNICATIONS TECHNICIAN I/II
SAN DIEGO, CALIFORNIA

The County of San Diego Dept. of Information Services is seeking qualified applicants for Telecommunications Technician I and II. Responsibilities include the installation, maintenance, and repair of land, mobile, audio, intercom, telephone, and microwave transmitter and receiver systems. Telecommunications Technician I requires two years of telecommunications experience, with at least one year of testing, repairing, and maintaining telecommunications equipment for mobile radios, microwave, telephone sets, or other relatively complex electronic systems. Telecommunications Technician II requires three years of experience with VHF, UHF, SHF (microwave), and two-way radio telecommunications equipment. Both positions require possession of a valid Federal Communications Commision General Radiotelephone Operator License or equivalent certificate.

The Salary range for Telecommunications Technician I is $26,561-$32,281; and the salary range for Telecommunications Technician II is $31,532-$38,355. Applications may be obtained by contacting the County of San Diego Department of Human Resources, 1600 Pacific Highway, Room 207, San Diego, CA 92101 (619) 236-2191

Employment

WESTLINK Paging, a nationally recognized leader in personal communications and pioneer in up-coming PCS, has opportunities in Albuquerque, NM. for a Technical Manager and Portland, OR., Salt Lake City, UT. and Minneapolis, MN for Systems Technicians to conduct preventative maintenance checks on transmitters & system-related equipment. The Candidate must be able to execute established maintenance of paging terminal and radio equipment. The Candidate must be highly organized and have the ability to manage and interface with independent contractors. Candidate must have an Associates degree in Electronics or Radio-related field or equivalent experience and an FCC General Class Radio license or NABER Certification. Westlink Paging offers a competitive salary and an excellent benefits package. Please send Resumé to:

Westlink Paging
Attn: Engineering Manager
11061 N.E. 2nd Street, Suite 107
Bellevue, WA 98004

EOE. Employment is conditioned upon the applicant undergoing and passing a pre-employment drug test.

Employment

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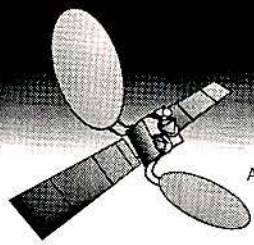

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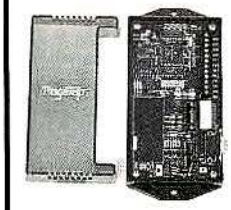

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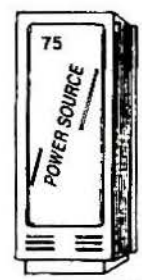

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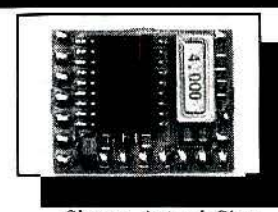

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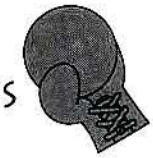

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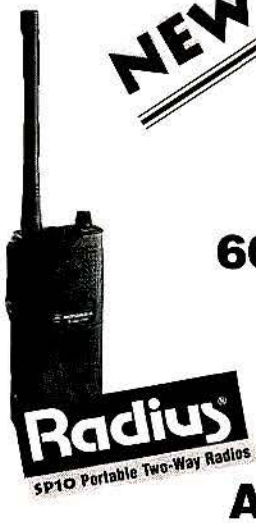

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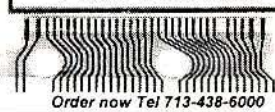

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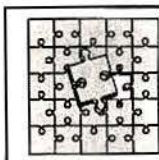

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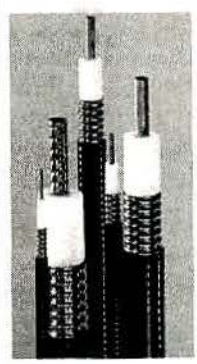

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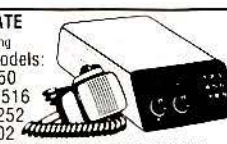

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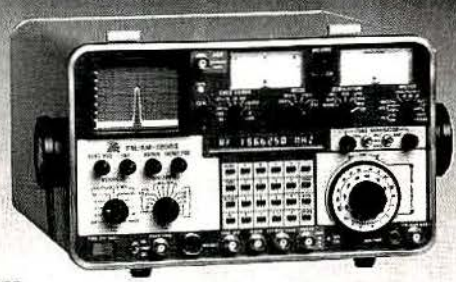

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Tower space

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RUGGED LARGE RED NYLON ID-ER TAGS WITH WHITE IDENTIFICATION NUMBER ENGRAVED ON BOTH SIDES. ID-ER TAGS ATTACH AT ANTENNA PIG TAIL, XMISSION-LINE, LINE ENTERING BUILDING, AND ON EQUIPMENT. ID-ER PACKAGE CONTAINS 4 EACH OF 12 SEQUENTIAL NUMBERS FROM 1 TO 12. (TOTAL 48 TAGS W/ TIES)
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- Lighting & Security Alarm Equipment
- Central Station Monitoring

Dealer Inquiries Welcome

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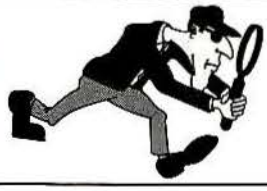

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- 41.1% circulation*

* based on June 1995 BPA.

Ad index/hot line

Company	Page Number	Fast Fact Number	Advertiser Hotline
Air Comm	80,81	85,88	602-275-4505
AF Comm Supply	81	89	800-255-6222
Allen Telecom Group	IFC	1	800-676-5342
Andrew Corporation	35	29	708-349-3300
Anritsu Wiltron Sales Co.	32A-B,33	27	800-230-2972
APE South	45	37	305-451-4722
Astron Corporation	7	7	714-458-7277
Avcom of Virginia	65	58	804-794-2500
Barnett Electronics	79	81	800-423-3858
Bird Electronic Corp	54	45	216-248-1200
Broadcast Communications	67	61	800-872-7513
Cadex Electronics Inc.	48	39	604-451-7900
Cartwright Communications	70	63	800-543-8614
Castle Tower Corporation	87	102	713-789-7651
Centurion International Inc.	9	8	800-228-4563
Chargeguard Corp.	75	72	800-458-3410
City of Fort Worth	79	82	817-871-8461
David Clark Co.,Inc.	12	9	508-751-5800
Communication Instruments	85		970-962-9998
Communications Services Co.	78	79	800-875-5109
Communications Specialists	BC	3	800-854-0547
Connect Systems, Inc.	13	10	800-545-1349
Control Signal Corp	22	19	303-989-8000
Diablo Communications, Inc.	86	100	510-236-3700
Direct Power & Water Corp.	22	54	505-889-3585
Doppler Systems, Inc.	56	47	602-488-9755
Douglas Integrated Software	84	95	800-845-0408
DuraComm Corp.	64	57	816-746-8300
DX Radio Systems	59	52	213-257-0800
El Paso Communication Systems	69	60	915-533-5119
EMR Corp	56	48	602-581-2875
Engineered Endeavors Inc.	37	30	216-974-6060
E Trunk Systems, Inc.	78	80	914-245-1128
Harger Lightning Protection	58	50	847-548-8700
HARK Electronic Systems	49	40	803-875-4480
Hutton Communications	21	18	800-442-3811
Hy-Q International	75	72	606-283-5000
IBC Technical Services Ltd.	55		
IFR Systems, Inc.	19	15	316-522-4981
J.E.I.	67	59	916-677-3210
JFW Industries Inc.	40	32	317-887-1340
Kenwood U.S.A. Corporation	51	42	310-639-4200
KNS Electronics Inc.	85	97	408-432-8100
LandmarkTower Corp.	63	56	817-335-8666
Larsen Electronics	23	21	800-426-1656
Marketronics	16	13	800-845-1230
Maxon America Inc.	41	33	816-891-6320
McManus Communications	83	92	501-763-6250
Mechem Electronics	79	84	703-891-0569
Meridian Communications	29	24	818-222-5655
Midian Electronics Inc.	15	12	602-884-7981
Modular Communication Systems	32	26	818-764-1333
Motorola Test Equipment	5	6	800-505-TEST
MX-COM, Inc.	76	74	800-638-5577
Norcomm Corp.	58	51	916-477-8400
NSI, Ltd.	75	73	206-661-1197
Orbacom Systems Inc.	17	14	609-829-4455
Ortel Corporation	39	31	818-281-3636
Pageco	82	90	305-776-0031
Pirod, Inc.	70	62	219-936-4221
Polaris Industries	77	78	800-752-3571
Polyphaser Corporation	34	28	800-325-7170
Power Conversion Products	47	38	815-459-9100
Radio Express, Inc.	78	81	703-266-1928
RAM Communications Consultants, Inc.	72	70	908-636-6970
Ramsey Electronics, Inc.	83	93	800-446-2295
RCW Distributing	76	75	800-726-9015
RELM Communications	IBC	2	800-648-0947
RMS Communications Group	82	91	800-627-2022
Rocky Mountain Comms. Inc.	84		303-526-5454
Santa Fe Distributing	62	55	913-492-8288
Serviceware Corporation	20	16	613-521-7391
Sharp Communication	79	83	800-548-2484
Shure Brothers Inc.	31	25	800-25S-HURE
Sinclair Technologies Inc.	57	49	905-727-0165
SoftWright	84	94	303-344-5486
Solar Electric Specialties	60	53	800-344-2003
Stealth Network Technologies	20	17	614-798-8783
Survey Technology	50	41	503-591-5986
Telepoint Inc.	52	43	310-652-3666
TESSCO	25,27		800-472-7373
Times Microwave Systems	44	36	203-949-8400
TowerWatch	87	101	800-475-1780
Transcrypt International, Ltd.	3	5	800-276-8799
Valmont Industries, Inc.	42	34	402-359-2201
Vega, A Mark IV Company	1	4	818-442-0782
Vocom Products Company LLC	28	23	800-USA-MADE
Wacom Products Inc.	61	20	817-848-4435
West Coast Radio	80	86	310-268-2464
Wetec Electronics	77,81	77,87	901-286-6275
Wilmore Electronics Company	24	22	919-732-9351
Zetron, Inc.	14,43,53	11,35,44	206-820-6363

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- 40 watts power VHF (150-174 MHz)
  25 watts power UHF (450-482 MHz)
- 16 or 99 channel capability with Scan
- Built-in CTCSS & DCS
- Extremely easy, user friendly operation

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- 40 watts power VHF (150-174 MHz)
  25 watts power UHF (450-482 MHz)
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  Great for Talk-Back Paging applications

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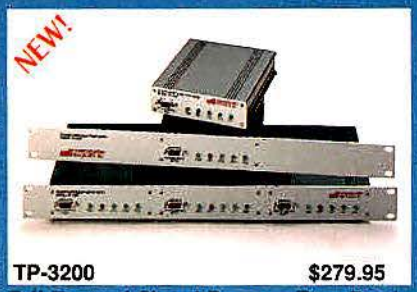
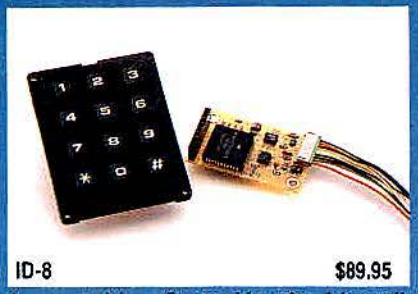


TP-3200 $279.95

Full Featured Shared Repeater Tone Panel with ALL 157 CTCSS/DCS codes. In Desktop or Rack Mount version.

CSI-100 $749.95

Video Modem. Sends and receives broadcast quality, single frame, color video over ANY narrow band communications channel.



ID-8 $89.95

Automatic Morse Station Identifier. Meets all FCC ID Requirements. Fully field programmable with included keypad. 1.85" x 1.12" x .35"

TE-64 $79.95

Self-contained Encoder, Rotary Dial Selection. Great for the Benchtop. 5.25" x 3.3" x 1.7"

CC-1/CR-1 $49.95 each

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PE-1000 $224.95

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PE-2P $54.95

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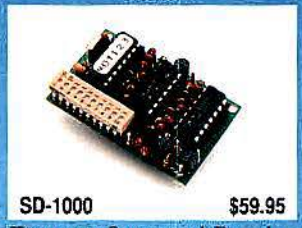

SD-1000 $59.95

Two-tone Sequential Decoder. Programmable unit provides switched outputs from two-tone paging calls. 1.25" x 2.0" x .4"

DTD-1 $59.95

Single Function DTMF Decoder. Provides switch outputs via DTMF. 1.25" x 2.0" x .4"

PE-4/PE-15 $99.95

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DCS-23 $59.95

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TS-32P $57.95

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TS-64 $64.95

Sub-miniature Programmable CTCSS Encoder-Decoder. 1.7" x .78" x .25"

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